IFA
Institut für Arbeitsschutz der
Deutschen Gesetzlichen Unfallversicherung

Proficiency testing for in-house measuring laboratories – Results and Evaluation

Proficiency testing scheme Metals on filters

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Institute for Occupationial Safety and Health of the
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Summary of laboratory test results

Sample 1

	Lead	Z score	Cobalt	Z score	Indium	Z score	Copper	Z score	Manganese	Z score
Unit	µg absolut		µg absolut		µg absolut		µg absolut		µg absolut	
13	41,900	1,25	3,370	0,55	0,722	0,57	2,320	0,12	3,740	0,27
33	37,000	-0,06	2,760	-1,36	0,598	-1,24	2,040	-1,10	3,200	-1,21
38	37,000	-0,06	3,300	0,33	0,700	0,25	2,400	0,47	3,700	0,16
54	37,800	0,15	3,160	-0,11	0,648	-0,51	2,150	-0,62	3,700	0,16
68	38,500	0,34	3,300	0,33			2,300	0,03	3,700	0,16
70	35,200	-0,55	3,170	-0,08			2,280	-0,06	3,490	-0,42
71	38,360	0,30	3,450	0,80	0,521	-2,37 BE	2,440	0,64	4,130	1,34
84	33,800	-0,92	2,910	-0,89			2,130	-0,71	3,190	-1,24
90	37,440	0,06	3,140	-0,17	0,680	-0,04	2,200	-0,41	3,450	-0,53
91	34,400	-0,76	3,010	-0,58			2,250	-0,19	3,430	-0,58
101	38,380	0,31	3,037	-0,49	0,669	-0,20	2,201	-0,40	3,451	-0,52
106	35,910	-0,36	3,090	-0,33	0,700	0,25	2,200	-0,41	3,490	-0,42
113	33,800	-0,92	2,880	-0,98			2,770	2,08 BE	2,270	-3,77 BE
116	46,000	2,35 BE	3,280	0,27			2,370	0,34	3,650	0,02
129	38,930	0,46	3,560	1,14			2,200	-0,41	3,730	0,24
131	38,051	0,22	3,360	0,52	0,720	0,54	2,392	0,43	3,785	0,39
150	40,100	0,77	3,430	0,74					4,210	1,56
177	27,100	-2,72 BE	2,900	-0,92					3,500	-0,39
188	36,940	-0,08	3,260	0,20			2,410	0,51	3,750	0,30
197	39,800	0,69	3,120	-0,23			2,340	0,20	3,990	0,96
201	34,590	-0,71	3,312	0,37			2,440	0,64	3,220	-1,16
218	36,210	-0,28	3,160	-0,11			2,300	0,03	3,560	-0,22
231	37,120	-0,03	3,210	0,05	0,654	-0,42	2,280	-0,06	3,720	0,22
242	37,540	0,08	3,320	0,39			2,410	0,51	3,800	0,44
252	36,970	-0,07	3,300	0,33	0,710	0,40	2,380	0,38	3,680	0,11
255	36,946	-0,08	3,073	-0,38			2,210	-0,36	3,623	-0,05
513	38,190	0,26	3,390	0,61	0,710	0,40	2,390	0,42	3,790	0,41
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	Lead	Z score	Cobalt	Z score	Indium	Z score	Copper	Z score	Manganese	Z score
Method	ISO 5725-2		ISO 5725-2		ISO 5725-2		ISO 5725-2		ISO 5725-2	
Assessment	|Z|<=2,00		|Z|<=2,00		|Z|<=2,00		|Z|<=2,00		|Z|<=2,00	
No. of laboratories that submitted results	27		27		12		25		27	
Mean	37,235		3,195		0,683		2,293		3,642	
Reprod. s.d.	1,953		0,194		0,038		0,109		0,250	
Rel. reproducibility s.d.	5,25 %		6,07 %		5,56 %		4,75 %		6,87 %	
Reference value	35,800		3,250		0,680		2,270		3,770	
Target s.d.	3,724		0,319		0,068		0,229		0,364	
Rel. target s.d.	10,00 %		10,00 %		10,00 %		10,00 %		10,00 %	
Low er limit of tolerance	29,788		2,556		0,546		1,834		2,913	
Upper limit of tolerance	44,682		3,833		0,819		2,752		4,370	
Type B outliers	2				1		1		1	
No. of laboratories after elimination of outliers type A-D and F (w ithout laboratories that only gave states but no measured values)	25		27		11		24		26	

Explanation of outlier types	
A: Single outlier	Grubbs
B: Differing laboratory mean	Grubbs
C: Excessive laboratory s.d.	Cochran
D: Excluded manually	
E: mean outside tolerance limits	
F: |Z-Score|>3,5	

	Nickel	Z score	Zinc	Z score
Unit	µg absolut		µg absolut	
13	5,380	0,69	21,100	1,63
33	4,500	-1,06	16,500	-0,91
38	5,200	0,33	19,000	0,47
54	4,730	-0,60	16,400	-0,96
68	5,200	0,33	19,400	0,69

	Nickel	Z score	Zinc	Z score	
70	4,410	-1,24	17,400	-0,41	
71	5,810	1,54	19,610	0,81	
84	4,660	-0,74	15,900	-1,24	
90	4,690	-0,68	17,000	-0,63	
91	4,640	-0,78	16,550	-0,88	
101	4,718	-0,63	17,270	-0,48	
106	4,780	-0,50	18,200	0,03	
113	4,430	-1,20	17,970	-0,10	
116	5,120	0,17	18,700	0,30	
129	5,800	1,52	19,830	0,93	
131	5,237	0,40	20,225	1,15	
150	5,990	1,90			
177	5,000	-0,07	14,500	-2,01	E
188	5,110	0,15	18,670	0,29	
197	4,970	-0,13	17,300	-0,47	
201	4,960	-0,15	17,690	-0,25	
218	4,860	-0,34	16,050	-1,16	
231	5,110	0,15	18,660	0,28	
242	5,250	0,43	19,460	0,72	
252	5,060	0,05	20,580	1,34	
255	4,993	-0,08	18,387	0,13	
513	5,290	0,51	19,470	0,73	
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Method	ISO 5725-2		ISO 5725-2		
Assessment	|Z|<=2,00		|Z|<=2,00		
No. of laboratories that submitted results	27		26		
Mean	5,033		18,147		
Reprod. s.d.	0,402		1,616		
Rel. reproducibility s.d.	7,99 %		8,90 %		
Reference value	4,700		18,890		
Target s.d.	0,503		1,815		
Rel. target s.d.	10,00 %		10,00 %		
Low er limit of tolerance	4,027		14,518		

	Nickel	Z score	Zinc	Z score
Upper limit of tolerance	6,040		21,776	
No. of laboratories after elimination of outliers type A-D and F (without laboratories that only gave states but no measured values)	27		26	

Summary of laboratory test results

Sample 2

	Lead	Z score	Cobalt	Z score	Indium	Z score	Copper	Z score	Manganese	Z score
Unit	µg absolut		µg absolut		µg absolut		µg absolut		µg absolut	
13	32,400	1,84	0,856	9,89 BE	0,155	0,40	7,090	1,63 B	17,100	2,38 BE
33	28,300	0,34	0,373	-1,33	0,135	-0,95	5,580	-0,85	12,700	-0,80
38	27,000	-0,14	0,430	-0,01	0,150	0,06	6,300	0,33	14,000	0,14
54	27,200	-0,06	0,385	-1,06	0,142	-0,48	5,630	-0,77	13,500	-0,22
68	28,500	0,41	0,500	1,62			6,200	0,17	14,100	0,21
70	27,100	-0,10	0,520	2,08 E			6,070	-0,05	14,100	0,21
71	28,740	0,50	0,446	0,36	0,291	9,52 BE	6,360	0,43	14,600	0,57
84	25,400	-0,72	0,360	-1,64			5,990	-0,18	12,700	-0,80
90	27,880	0,18	0,420	-0,24	0,150	0,06	5,910	-0,31	13,400	-0,30
91	26,830	-0,20	< 0,460				6,520	0,69	13,990	0,13
101	30,100	1,00	0,418	-0,29	0,151	0,13	6,119	0,03	13,860	0,04
106	26,490	-0,32	0,420	-0,24	0,160	0,73	5,960	-0,23	13,450	-0,26
113	24,600	-1,01	0,368	-1,45			5,390	-1,16	11,790	-1,46
116	28,400	0,37	0,440	0,22			6,390	0,48	14,000	0,14
129	26,600	-0,28	0,520	2,08 E			6,070	-0,05	14,660	0,62
131	27,511	0,05	0,428	-0,06	0,153	0,26	6,158	0,10	14,197	0,28
150	28,360	0,36	0,450	0,45					15,800	1,44
177	22,700	-1,71	0,500	1,62			11,800	9,35 BE		
188	26,840	-0,19	0,410	-0,47			6,120	0,04	13,950	0,10
197	29,400	0,74	0,410	-0,47			6,270	0,28	15,000	0,86
201	26,260	-0,41	0,410	-0,47			6,546	0,73	11,820	-1,44
218	26,830	-0,20	0,420	-0,24			6,070	-0,05	13,900	0,07
231	27,860	0,18	0,435	0,11	0,144	-0,34	6,170	0,12	14,390	0,42
242	27,180	-0,07	0,420	-0,24			6,240	0,23	14,100	0,21
252	26,910	-0,17	0,440	0,22	0,150	0,06	6,250	0,25	13,900	0,07
255	27,041	-0,12	0,408	-0,52			5,922	-0,29	13,702	-0,08
513	26,660	-0,26	0,430	-0,01	0,150	0,06	6,120	0,04	13,600	-0,15
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	Lead	Z score	Cobalt	Z score	Indium	Z score	Copper	Z score	Manganese	Z score
Method	ISO 5725-2		ISO 5725-2		ISO 5725-2		ISO 5725-2		ISO 5725-2	
Assessment	|Z|<=2,00		|Z|<=2,00		|Z|<=2,00		|Z|<=2,00		|Z|<=2,00	
No. of laboratories that submitted results	27		27		12		26		26	
Mean	27,374		0,430		0,149		6,098		13,808	
Reprod. s.d.	1,769		0,042		0,007		0,276		0,879	
Rel. reproducibility s.d.	6,46 %		9,85 %		4,50 %		4,53 %		6,37 %	
Reference value	26,100		0,420		0,150		6,020		14,970	
Target s.d.	2,737		0,043		0,015		0,610		1,381	
Rel. target s.d.	10,00 %		10,00 %		10,00 %		10,00 %		10,00 %	
Low er limit of tolerance	21,899		0,344		0,119		4,878		11,047	
Upper limit of tolerance	32,849		0,517		0,179		7,318		16,570	
Type B outliers			1		1		2		1	
No. of laboratories after elimination of outliers type A-D and F (w ithout laboratories that only gave states but no measured values)	27		25		11		24		25	

Explanation of outlier types	
A: Single outlier	Grubbs
B: Differing laboratory mean	Grubbs
C: Excessive laboratory s.d.	Cochran
D: Excluded manually	
E: mean outside tolerance limits	
F: |Z-Score|>3,5	

	Nickel	Z score	Zinc	Z score
Unit	µg absolut		µg absolut	
13	4,570	0,30	35,000	2,68 E
33	4,120	-0,72	25,700	-0,69
38	4,500	0,14	29,000	0,50
54	4,190	-0,56	25,800	-0,66
68	4,700	0,59	29,500	0,68

	Nickel	Z score	Zinc	Z score
70	4,180	-0,58	27,700	0,03
71	5,130	1,56 B	29,090	0,53
84	4,310	-0,29	28,300	0,25
90	4,220	-0,49	26,330	-0,46
91	4,480	0,09	27,230	-0,14
101	4,379	-0,13	26,150	-0,53
106	4,280	-0,36	26,490	-0,41
113	4,470	0,07	23,400	-1,53
116	4,580	0,32	28,800	0,43
129	4,870	0,97	28,500	0,32
131	4,503	0,14	29,464	0,67
150	5,890	3,27 BE		
177	4,400	-0,09	20,600	-2,54 E
188	4,470	0,07	27,670	0,02
197	4,420	-0,04	26,400	-0,44
201	4,513	0,17	25,290	-0,84
218	4,410	-0,07	24,810	-1,02
231	4,620	0,41	29,330	0,62
242	4,470	0,07	29,190	0,57
252	4,440	0,00	30,830	1,16
255	4,487	0,11	28,218	0,22
513	4,390	-0,11	29,150	0,56
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Method	ISO 5725-2		ISO 5725-2	
Assessment	|Z|<=2,00		|Z|<=2,00	
No. of laboratories that submitted results	27		26	
Mean	4,439		27,613	
Reprod. s.d.	0,167		2,688	
Rel. reproducibility s.d.	3,77 %		9,73 %	
Reference value	4,050		29,460	
Target s.d.	0,444		2,761	
Rel. target s.d.	10,00 %		10,00 %	
Low er limit of tolerance	3,551		22,091	

	Nickel	Z score	Zinc	Z score
Upper limit of tolerance	5,327		33,136	
Type B outliers	2			
No. of laboratories after elimination of outliers type A-D and F (without laboratories that only gave states but no measured values)	25		26	

Summary of laboratory test results

Sample 3

	Lead	Z score	Cobalt	Z score	Indium	Z score	Copper	Z score	Manganese	Z score
Unit	µg absolut		µg absolut		µg absolut		µg absolut		µg absolut	
13	10,900	1,17	2,220	1,32	0,415	0,39	10,100	0,38	2,510	0,26
33	10,800	1,06	1,820	-0,72	0,381	-0,47	9,330	-0,41	2,350	-0,40
38	9,400	-0,37	1,900	-0,31	0,390	-0,24	9,700	-0,03	2,400	-0,19
54	9,920	0,16	1,960	0,00	0,381	-0,47	9,670	-0,06	2,550	0,42
68	10,200	0,45	2,000	0,20			9,500	-0,23	2,500	0,22
70	9,820	0,06	2,060	0,51			9,630	-0,10	2,470	0,09
71	9,110	-0,67	2,560	3,05 BE	0,404	0,11	8,880	-0,87	2,320	-0,52
84	8,300	-1,50	1,900	-0,31			9,800	0,07	2,300	-0,60
90	10,140	0,39	1,930	-0,16	0,400	0,01	9,420	-0,32	2,350	-0,40
91	9,730	-0,03	1,980	0,10			10,090	0,37	2,540	0,38
101	9,561	-0,21	1,948	-0,07	0,413	0,34	9,736	0,01	2,477	0,12
106	9,870	0,11	1,910	-0,26	0,400	0,01	9,070	-0,68	2,360	-0,36
113	8,620	-1,17	1,742	-1,12			7,630	-2,16 BE	1,230	-4,97 BE
116	10,200	0,45	2,010	0,25			10,100	0,38	2,460	0,05
129	12,530	2,84 BE	1,950	-0,06			9,930	0,21	2,400	-0,19
131	10,166	0,41	2,083	0,62	0,427	0,69	10,331	0,62	2,591	0,59
150	10,300	0,55	1,980	0,10					2,970	2,14 BE
177	8,600	-1,19	1,800	-0,82			14,800	5,21 BE	2,400	-0,19
188	9,750	-0,01	2,010	0,25			9,930	0,21	2,500	0,22
197	10,900	1,17	1,970	0,05			10,100	0,38	2,780	1,36 B
201	9,711	-0,05	2,010	0,25			9,910	0,19	2,276	-0,70
218	9,990	0,23	2,040	0,40			9,850	0,13	2,470	0,09
231	9,640	-0,12	1,930	-0,16	0,374	-0,64	9,510	-0,22	2,480	0,13
242	8,890	-0,89	2,020	0,30			9,980	0,26	2,560	0,46
252	9,660	-0,10	1,970	0,05	0,400	0,01	9,800	0,07	2,420	-0,11
255	9,544	-0,22	1,882	-0,40			9,100	-0,65	2,429	-0,07
513	10,070	0,32	1,960	0,00	0,410	0,26	10,000	0,28	2,620	0,71
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	Lead	Z score	Cobalt	Z score	Indium	Z score	Copper	Z score	Manganese	Z score
Method	ISO 5725-2		ISO 5725-2		ISO 5725-2		ISO 5725-2		ISO 5725-2	
Assessment	|Z|<=2,00		|Z|<=2,00		|Z|<=2,00		|Z|<=2,00		|Z|<=2,00	
No. of laboratories that submitted results	27		27		12		26		27	
Mean	9,761		1,961		0,400		9,728		2,447	
Reprod. s.d.	0,665		0,095		0,016		0,367		0,092	
Rel. reproducibility s.d.	6,81 %		4,82 %		3,95 %		3,77 %		3,78 %	
Reference value	9,890		2,010		0,410		9,290		2,700	
Target s.d.	0,976		0,196		0,040		0,973		0,245	
Rel. target s.d.	10,00 %		10,00 %		10,00 %		10,00 %		10,00 %	
Low er limit of tolerance	7,809		1,569		0,320		7,782		1,958	
Upper limit of tolerance	11,713		2,353		0,480		11,673		2,937	
Type B outliers	1		1				2		3	
No. of laboratories after elimination of outliers type A-D and F (w ithout laboratories that only gave states but no measured values)	26		26		12		24		24	

Explanation of outlier types	
A: Single outlier	Grubbs
B: Differing laboratory mean	Grubbs
C: Excessive laboratory s.d.	Cochran
D: Excluded manually	
E: mean outside tolerance limits	
F: |Z-Score|>3,5	

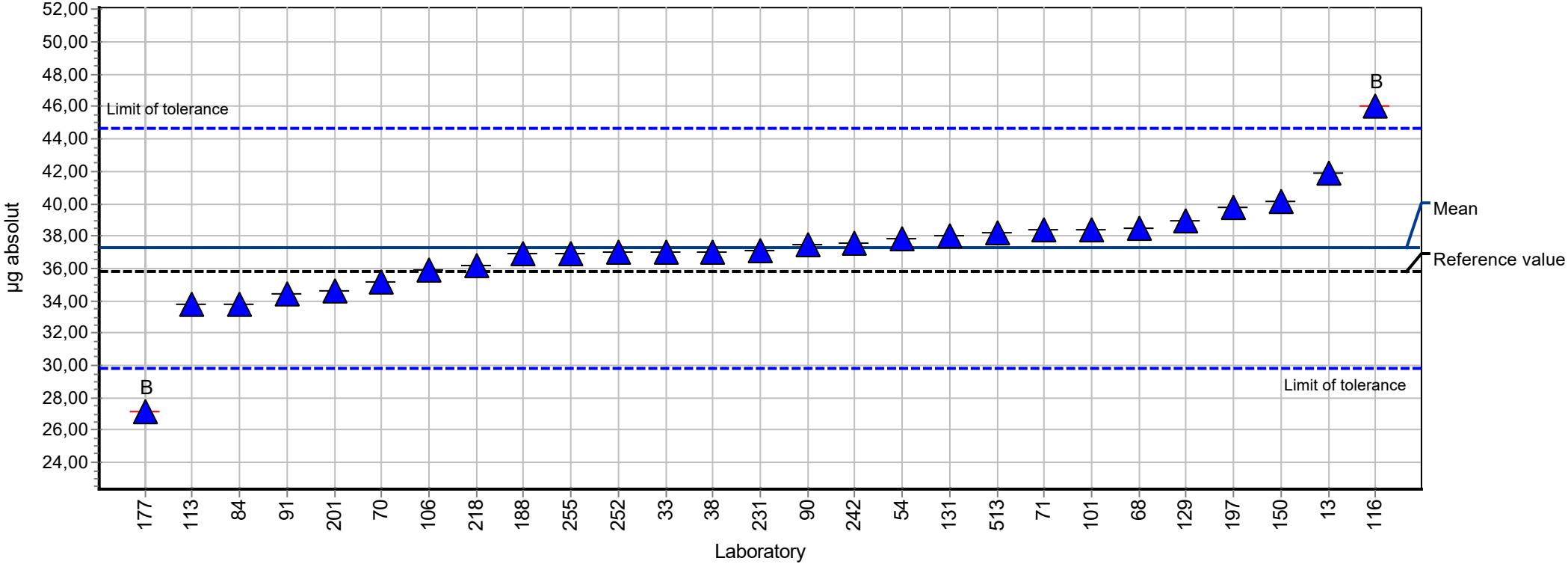
	Nickel	Z score	Zinc	Z score
Unit	µg absolute		µg absolut	
13	2,030	-0,08	53,100	0,77
33	2,090	0,21	47,300	-0,41
38	1,900	-0,72	49,000	-0,07
54	1,940	-0,52	46,000	-0,67
68	2,100	0,26	51,300	0,40

	Nickel	Z score	Zinc	Z score
70	1,740	-1,50	48,800	-0,11
71	1,990	-0,28	46,330	-0,61
84	2,000	-0,23	51,300	0,40
90	1,840	-1,01	47,290	-0,41
91	1,970	-0,37	47,220	-0,43
101	1,986	-0,30	46,370	-0,60
106	1,860	-0,91	46,970	-0,48
113	2,250	0,99	54,600	1,07
116	1,990	-0,28	51,000	0,34
129	2,500	2,22 E	49,170	-0,03
131	2,107	0,30	53,072	0,76
150	2,350	1,48		
177	2,400	1,73		
188	1,940	-0,52	50,140	0,17
197	2,040	-0,03	49,400	0,02
201	2,214	0,82	43,930	-1,09
218	1,980	-0,32	44,940	-0,89
231	2,010	-0,18	48,480	-0,17
242	2,020	-0,13	51,160	0,37
252	1,970	-0,37	54,210	0,99
255	1,996	-0,25	49,424	0,02
513	2,040	-0,03	52,610	0,67
–	–	– –	–	– –
Method	ISO 5725-2		ISO 5725-2	
Assessment	|Z|<=2,00		|Z|<=2,00	
No. of laboratories that submitted results	27		25	
Mean	2,046		49,325	
Reprod. s.d.	0,170		2,900	
Rel. reproducibility s.d.	8,30 %		5,88 %	
Reference value	1,790		52,030	
Target s.d.	0,205		4,932	
Rel. target s.d.	10,00 %		10,00 %	
Low er limit of tolerance	1,637		39,460	

	Nickel	Z score	Zinc	Z score
Upper limit of tolerance	2,456		59,190	
No. of laboratories after elimination of outliers type A-D and F (without laboratories that only gave states but no measured values)	27		25	

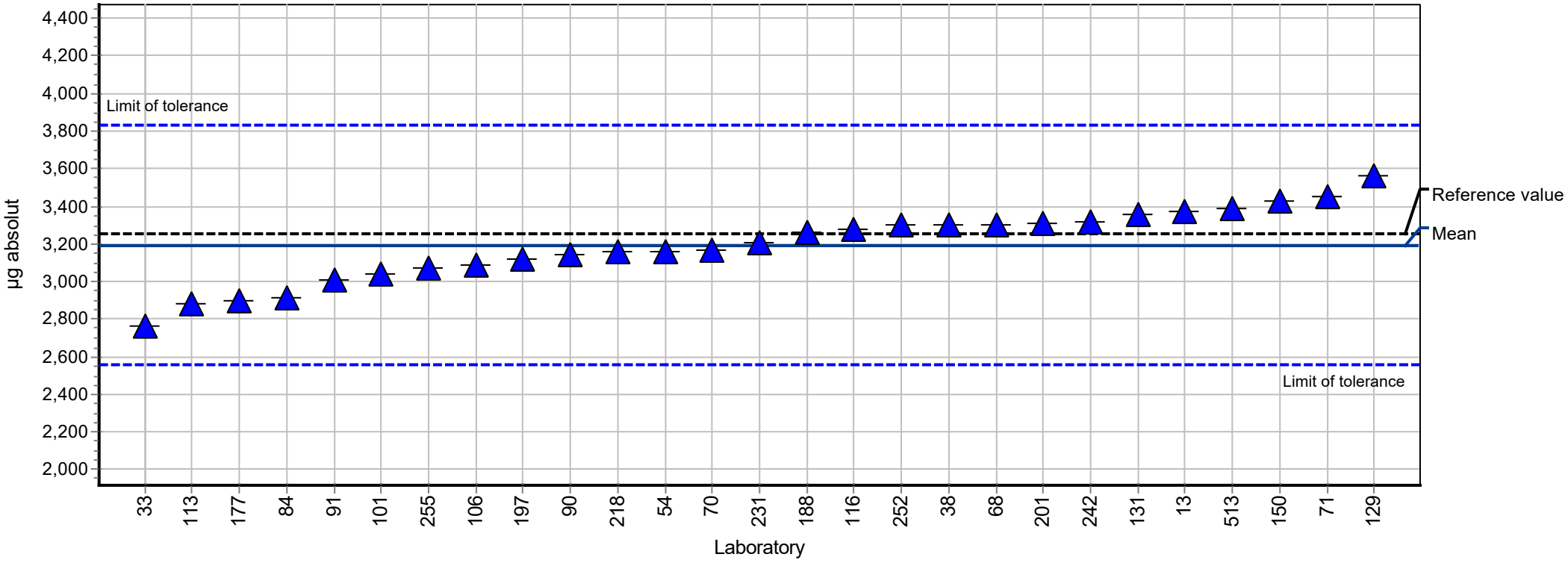
Summary results

Measurand:	**Lead**	**Mean:**	**37,235 µg absolut**
Sample:	**1**	**Reprod. s.d.:**	**1,953 µg absolut**
Method:	**ISO 5725-2**	**Rel.reprod. s.d.:**	**5,25%**
Rel.target s.d.:	**10,00% (Limited)**	**Reference value:**	**35,800 µg absolut**
Number of laboratories in calculation + outliers:	**27**	**Range of tolerance:**	**29,788 - 44,682 µg absolut (|Z-Score| <= 2,00)**



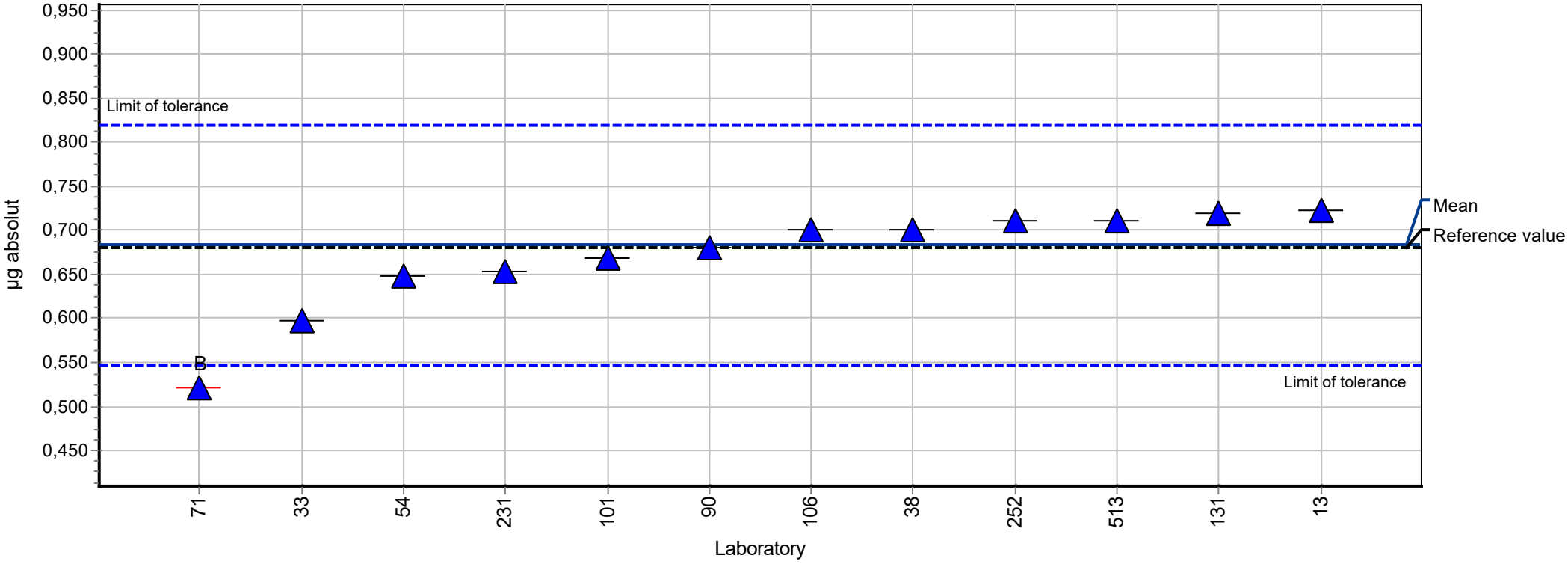
Summary results

Measurand:	**Cobalt**	**Mean:**	**3,195 µg absolut**
Sample:	**1**	**Reprod. s.d.:**	**0,194 µg absolut**
Method:	**ISO 5725-2**	**Rel.reprod. s.d.:**	**6,07%**
Rel.target s.d.:	**10,00% (Limited)**	**Reference value:**	**3,250 µg absolut**
Number of laboratories in calculation:	**27**	**Range of tolerance:**	**2,556 - 3,833 µg absolut (|Z-Score| <= 2,00)**



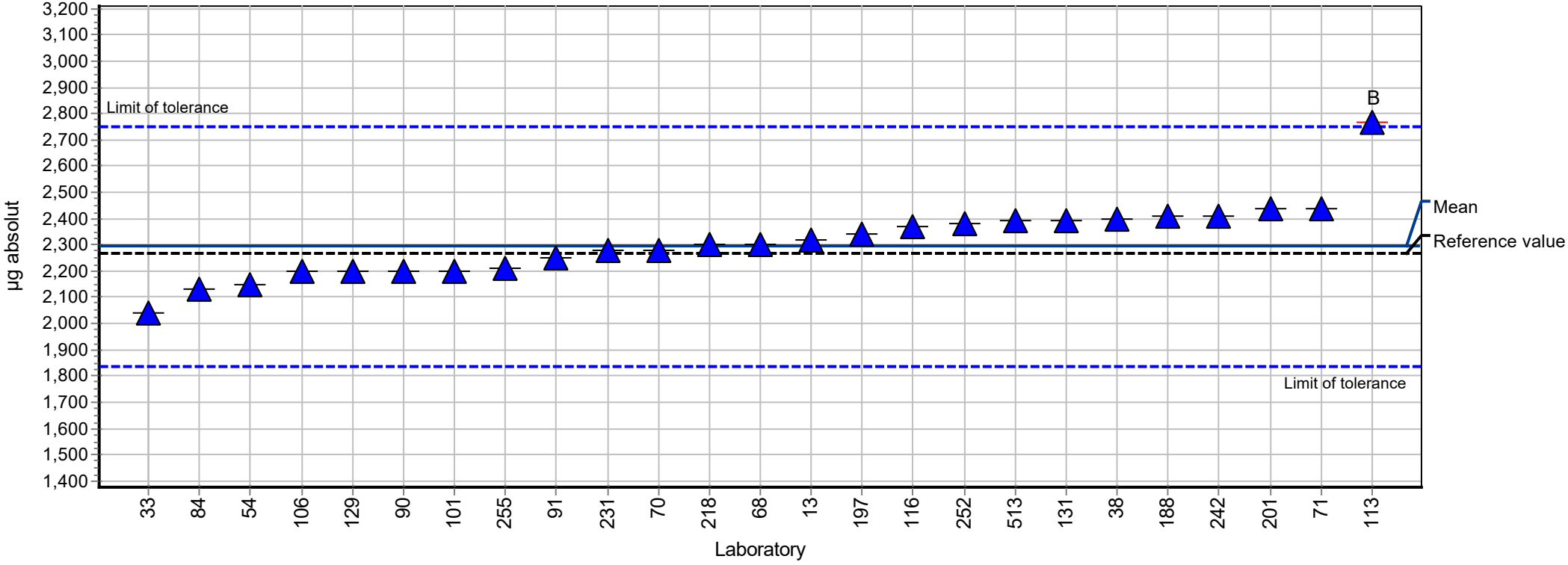
Summary results

Measurand:	**Indium**	**Mean:**	**0,683 µg absolut**
Sample:	**1**	**Reprod. s.d.:**	**0,038 µg absolut**
Method:	**ISO 5725-2**	**Rel.reprod. s.d.:**	**5,56%**
Rel.target s.d.:	**10,00% (Limited)**	**Reference value:**	**0,680 µg absolut**
Number of laboratories in calculation + outliers:	**12**	**Range of tolerance:**	**0,546 - 0,819 µg absolut (|Z-Score| <= 2,00)**



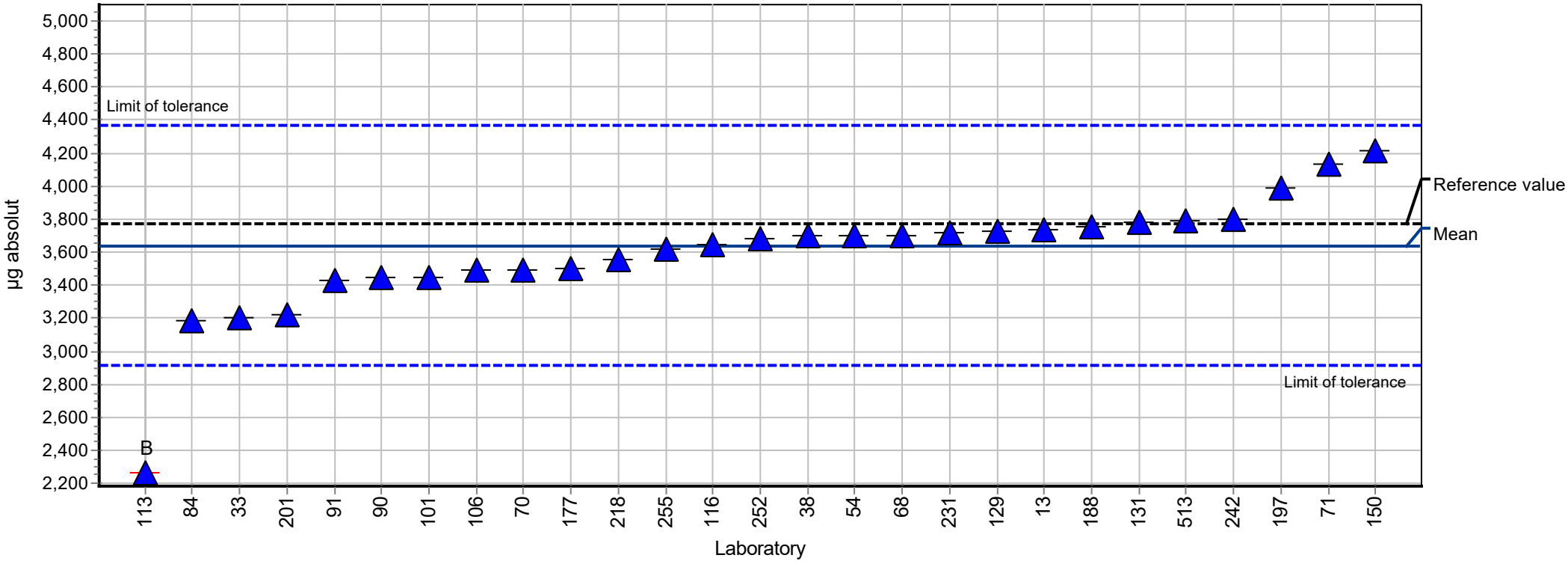
Summary results

Measurand:	**Copper**	**Mean:**	**2,293 µg absolut**
Sample:	**1**	**Reprod. s.d.:**	**0,109 µg absolut**
Method:	**ISO 5725-2**	**Rel.reprod. s.d.:**	**4,75%**
Rel.target s.d.:	**10,00% (Limited)**	**Reference value:**	**2,270 µg absolut**
Number of laboratories in calculation + outliers:	**25**	**Range of tolerance:**	**1,834 - 2,752 µg absolut (|Z-Score| <= 2,00)**



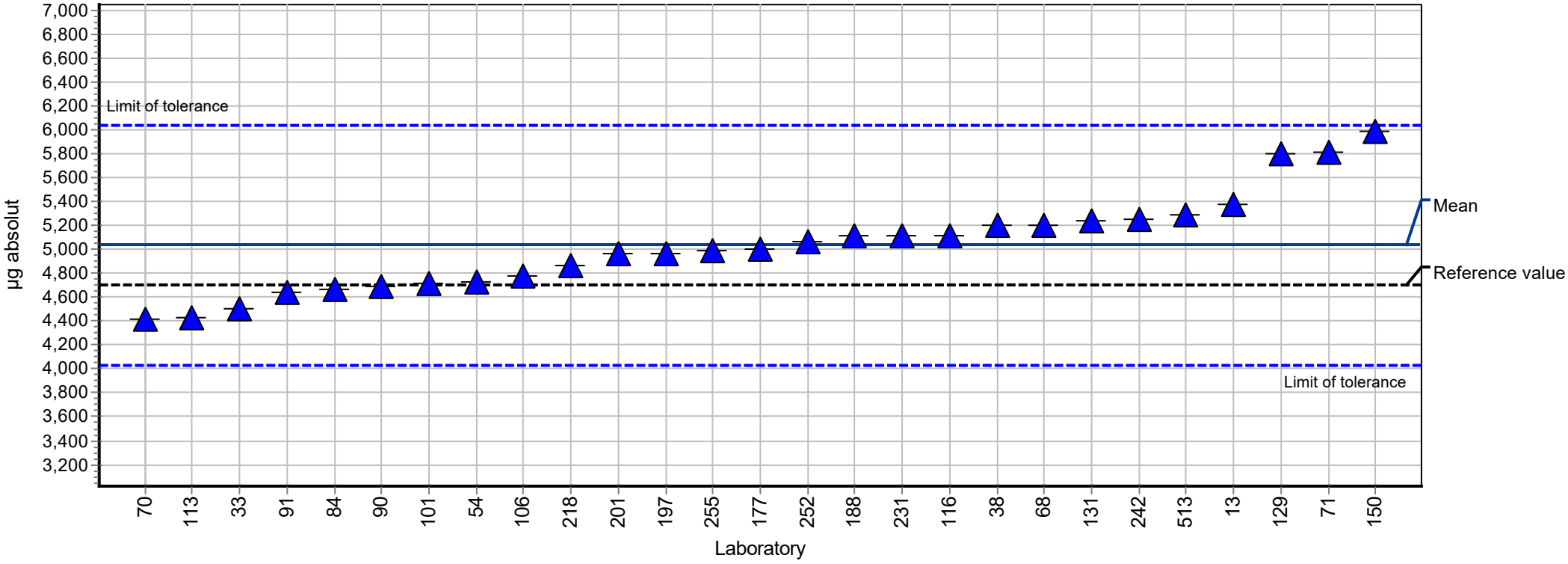
Summary results

Measurand:	**Manganese**	**Mean:**	**3,642 µg absolut**
Sample:	**1**	**Reprod. s.d.:**	**0,250 µg absolut**
Method:	**ISO 5725-2**	**Rel.reprod. s.d.:**	**6,87%**
Rel.target s.d.:	**10,00% (Limited)**	**Reference value:**	**3,770 µg absolut**
Number of laboratories in calculation + outliers:	**27**	**Range of tolerance:**	**2,913 - 4,370 µg absolut (|Z-Score| <= 2,00)**



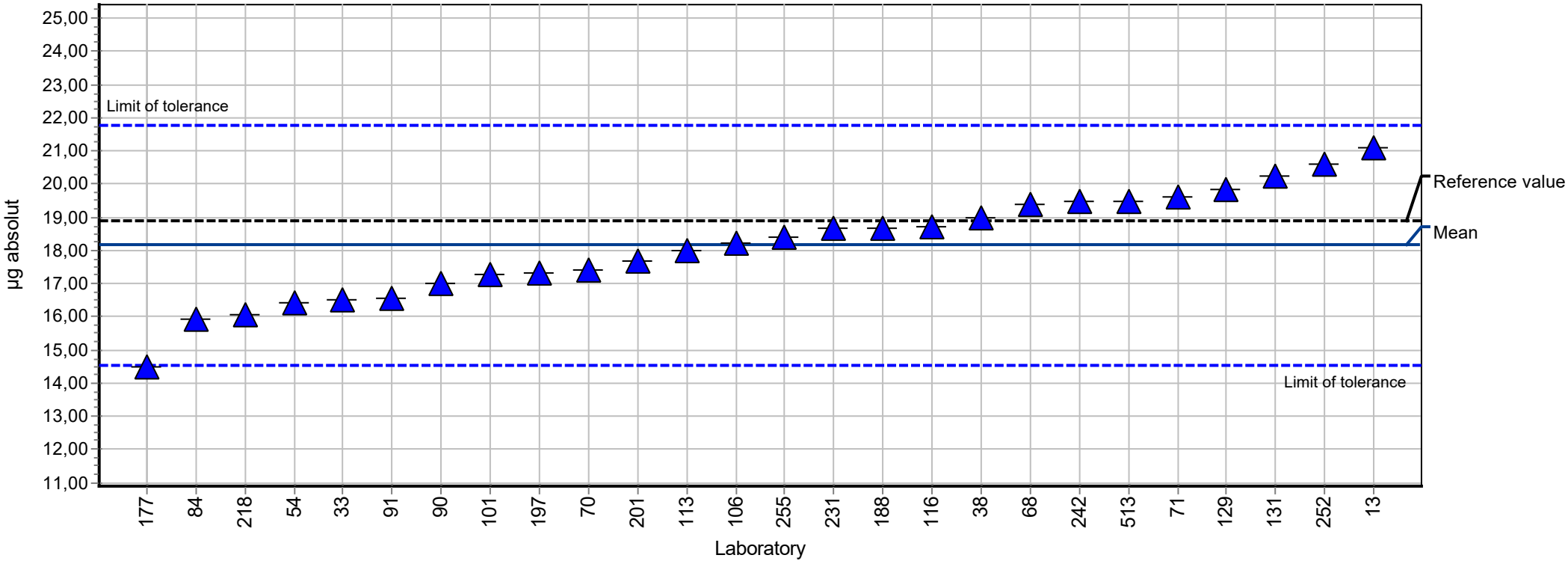
Summary results

Measurand:	**Nickel**	**Mean:**	**5,033 µg absolut**
Sample:	**1**	**Reprod. s.d.:**	**0,402 µg absolut**
Method:	**ISO 5725-2**	**Rel.reprod. s.d.:**	**7,99%**
Rel.target s.d.:	**10,00% (Limited)**	**Reference value:**	**4,700 µg absolut**
Number of laboratories in calculation:	**27**	**Range of tolerance:**	**4,027 - 6,040 µg absolut (|Z-Score| <= 2,00)**



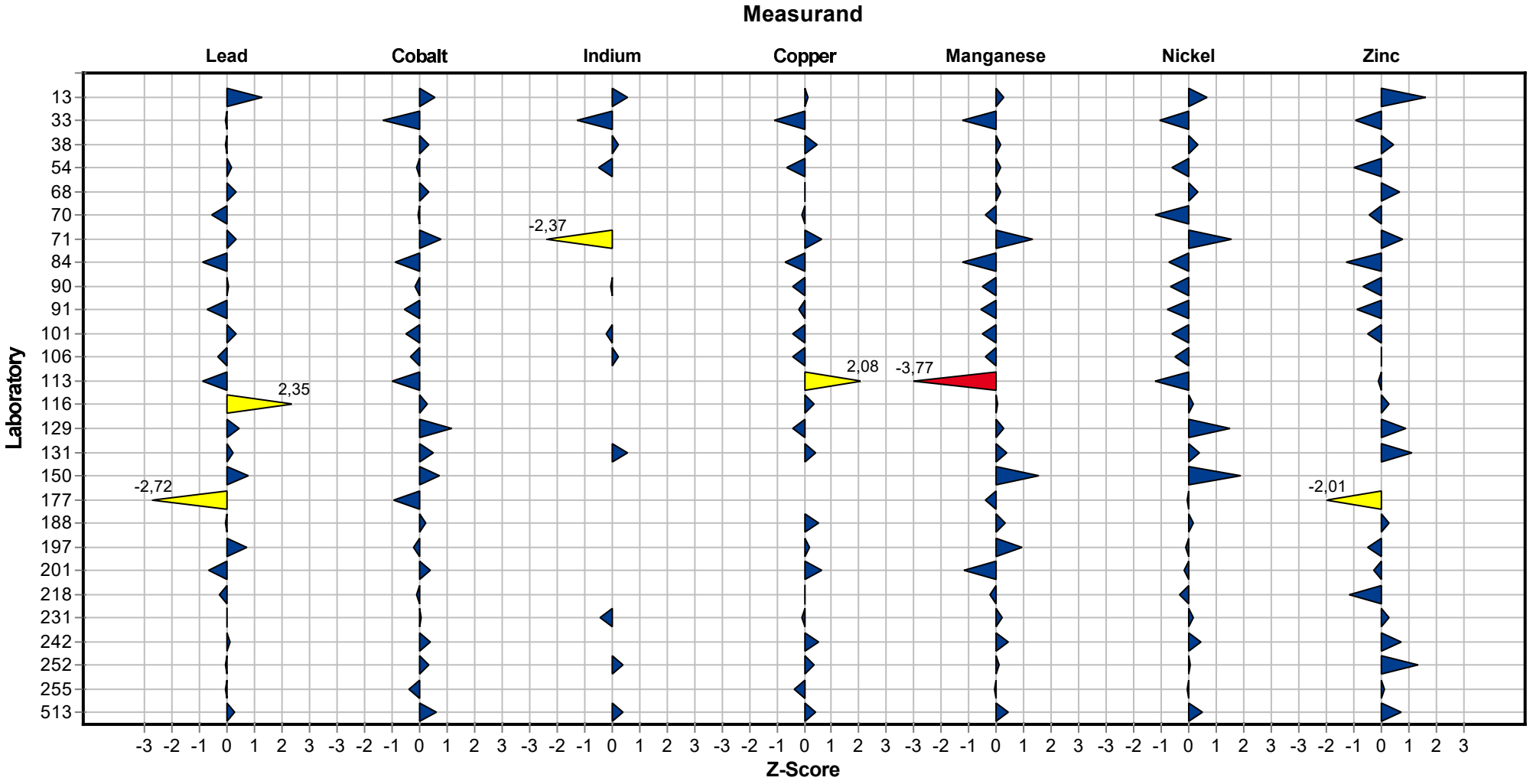
Summary results

Measurand:	**Zinc**	**Mean:**	**18,147 µg absolut**
Sample:	**1**	**Reprod. s.d.:**	**1,616 µg absolut**
Method:	**ISO 5725-2**	**Rel.reprod. s.d.:**	**8,90%**
Rel.target s.d.:	**10,00% (Limited)**	**Reference value:**	**18,890 µg absolut**
Number of laboratories in calculation:	**26**	**Range of tolerance:**	**14,518 - 21,776 µg absolut (|Z-Score| <= 2,00)**



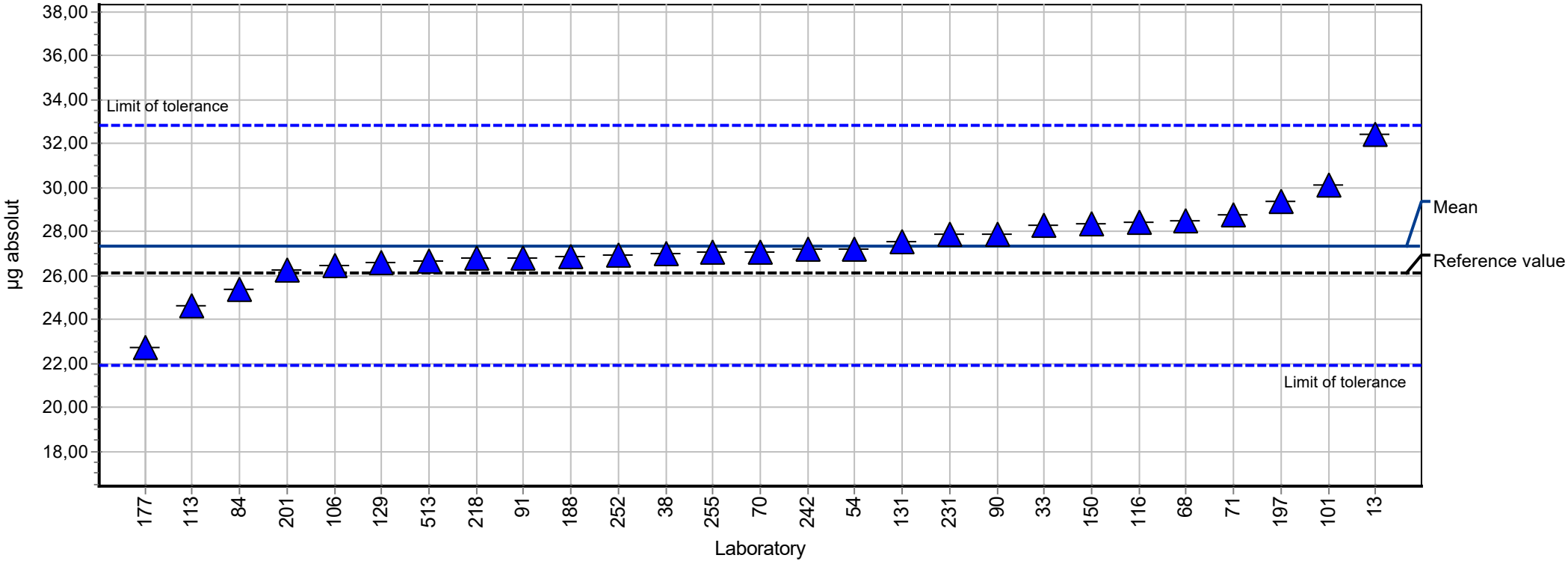
Sample chart of Z-scores

Sample 1



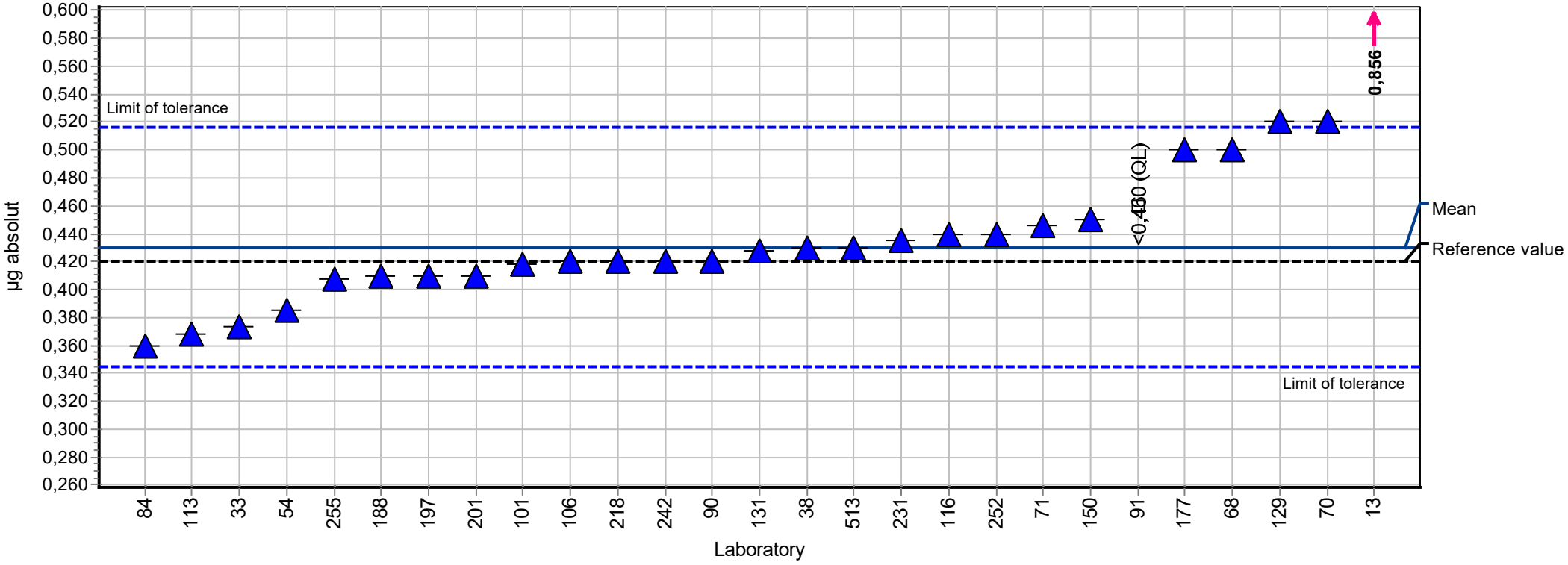
Summary results

Measurand:	**Lead**	**Mean:**	**27,374 µg absolut**
Sample:	**2**	**Reprod. s.d.:**	**1,769 µg absolut**
Method:	**ISO 5725-2**	**Rel.reprod. s.d.:**	**6,46%**
Rel.target s.d.:	**10,00% (Limited)**	**Reference value:**	**26,100 µg absolut**
Number of laboratories in calculation:	**27**	**Range of tolerance:**	**21,899 - 32,849 µg absolut (|Z-Score| <= 2,00)**



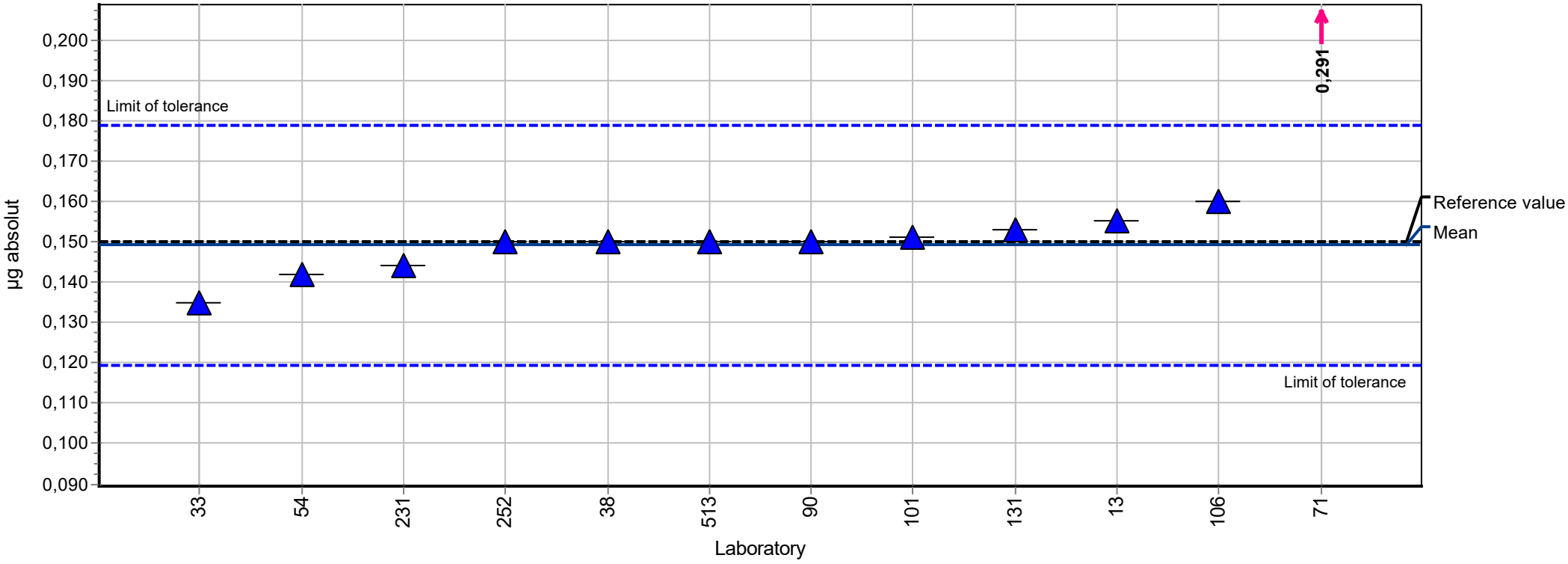
Summary results

Measurand:	**Cobalt**	**Mean:**	**0,430 µg absolut**
Sample:	**2**	**Reprod. s.d.:**	**0,042 µg absolut**
Method:	**ISO 5725-2**	**Rel.reprod. s.d.:**	**9,85%**
Rel.target s.d.:	**10,00% (Limited)**	**Reference value:**	**0,420 µg absolut**
Number of laboratories in calculation + outliers:	**26**	**Range of tolerance:**	**0,344 - 0,517 µg absolut (|Z-Score| <= 2,00)**



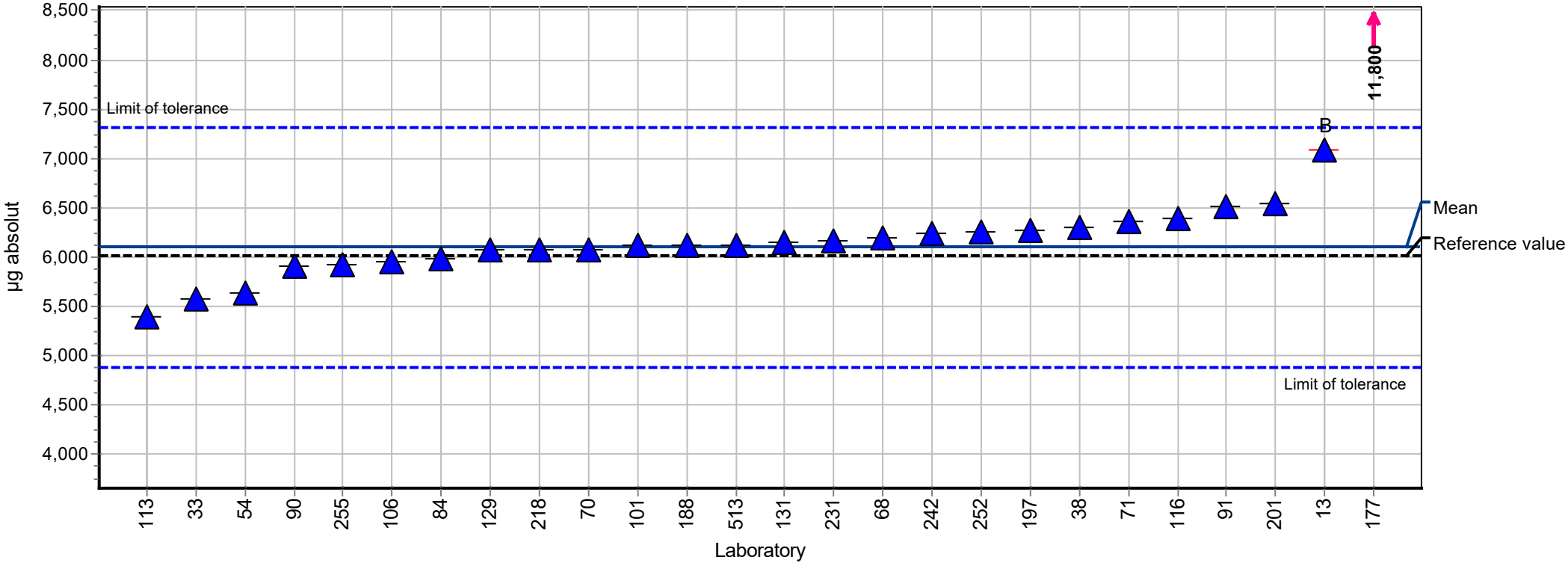
Summary results

Measurand:	**Indium**	**Mean:**	**0,149 µg absolut**
Sample:	**2**	**Reprod. s.d.:**	**0,007 µg absolut**
Method:	**ISO 5725-2**	**Rel.reprod. s.d.:**	**4,50%**
Rel.target s.d.:	**10,00% (Limited)**	**Reference value:**	**0,150 µg absolut**
Number of laboratories in calculation + outliers:	**12**	**Range of tolerance:**	**0,119 - 0,179 µg absolut (|Z-Score| <= 2,00)**



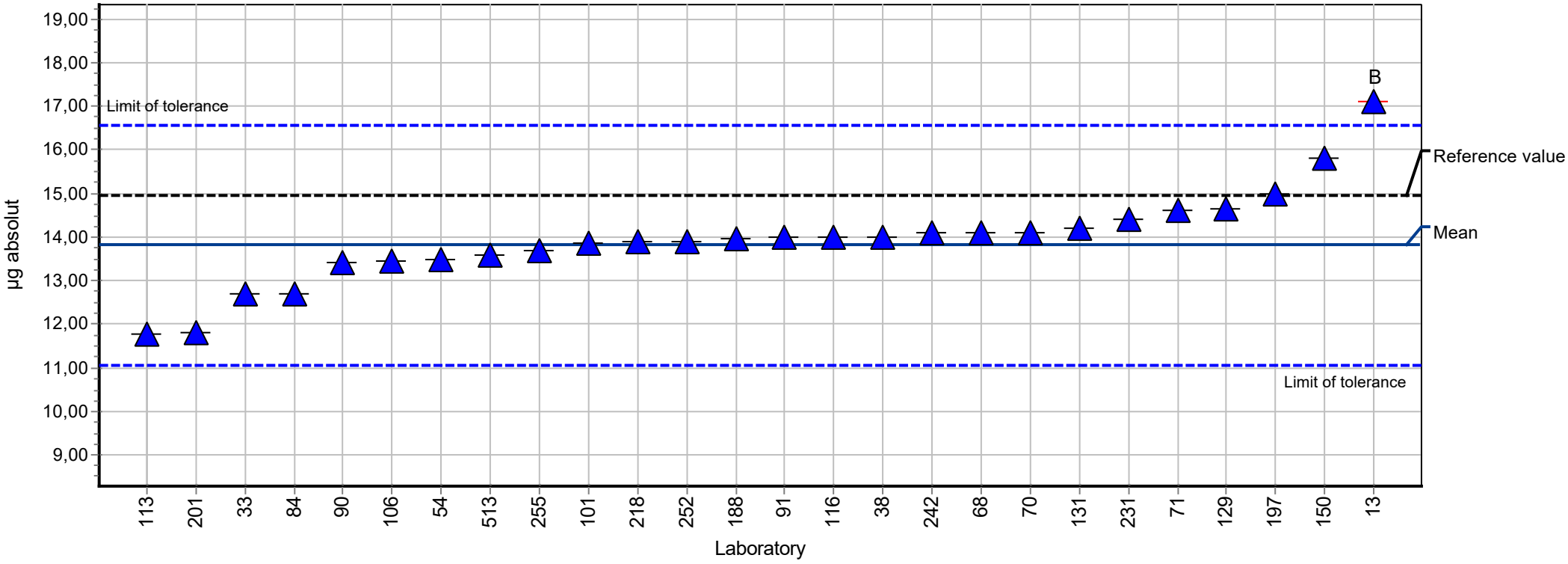
Summary results

Measurand:	**Copper**	**Mean:**	**6,098 µg absolut**
Sample:	**2**	**Reprod. s.d.:**	**0,276 µg absolut**
Method:	**ISO 5725-2**	**Rel.reprod. s.d.:**	**4,53%**
Rel.target s.d.:	**10,00% (Limited)**	**Reference value:**	**6,020 µg absolut**
Number of laboratories in calculation + outliers:	**26**	**Range of tolerance:**	**4,878 - 7,318 µg absolut (|Z-Score| <= 2,00)**



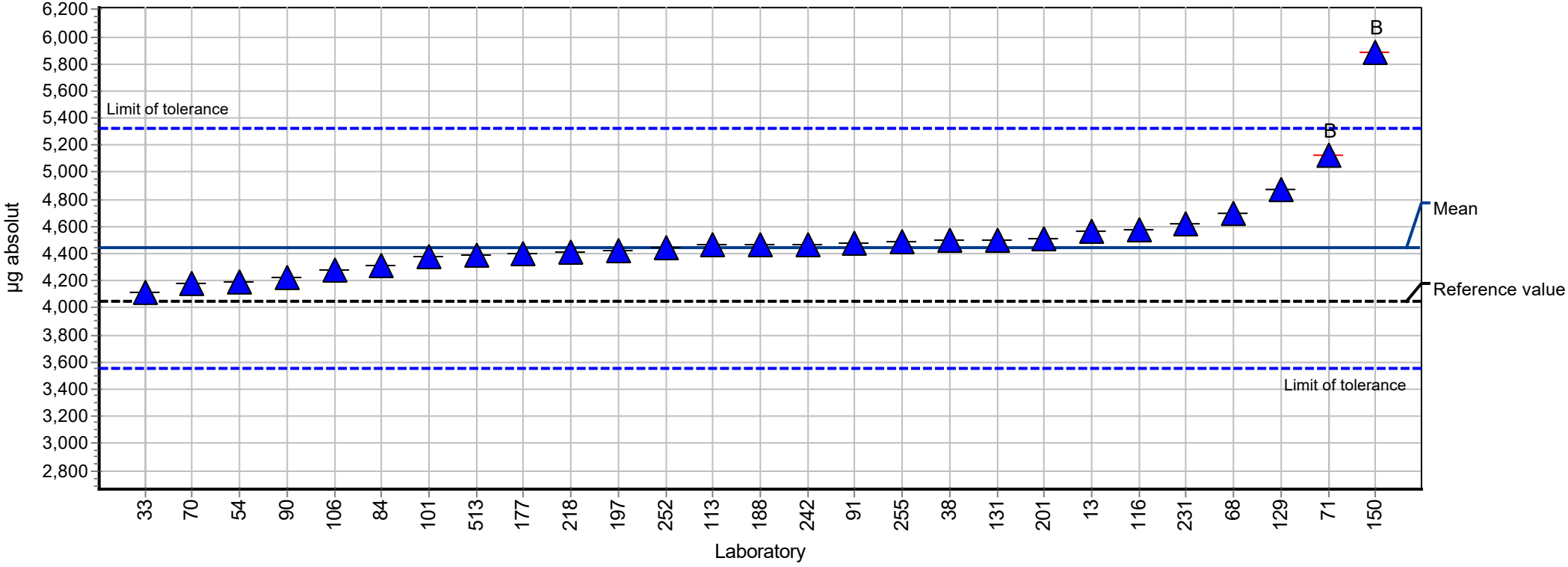
Summary results

Measurand:	**Manganese**	**Mean:**	**13,808 µg absolut**
Sample:	**2**	**Reprod. s.d.:**	**0,879 µg absolut**
Method:	**ISO 5725-2**	**Rel.reprod. s.d.:**	**6,37%**
Rel.target s.d.:	**10,00% (Limited)**	**Reference value:**	**14,970 µg absolut**
Number of laboratories in calculation + outliers:	**26**	**Range of tolerance:**	**11,047 - 16,570 µg absolut (|Z-Score| <= 2,00)**



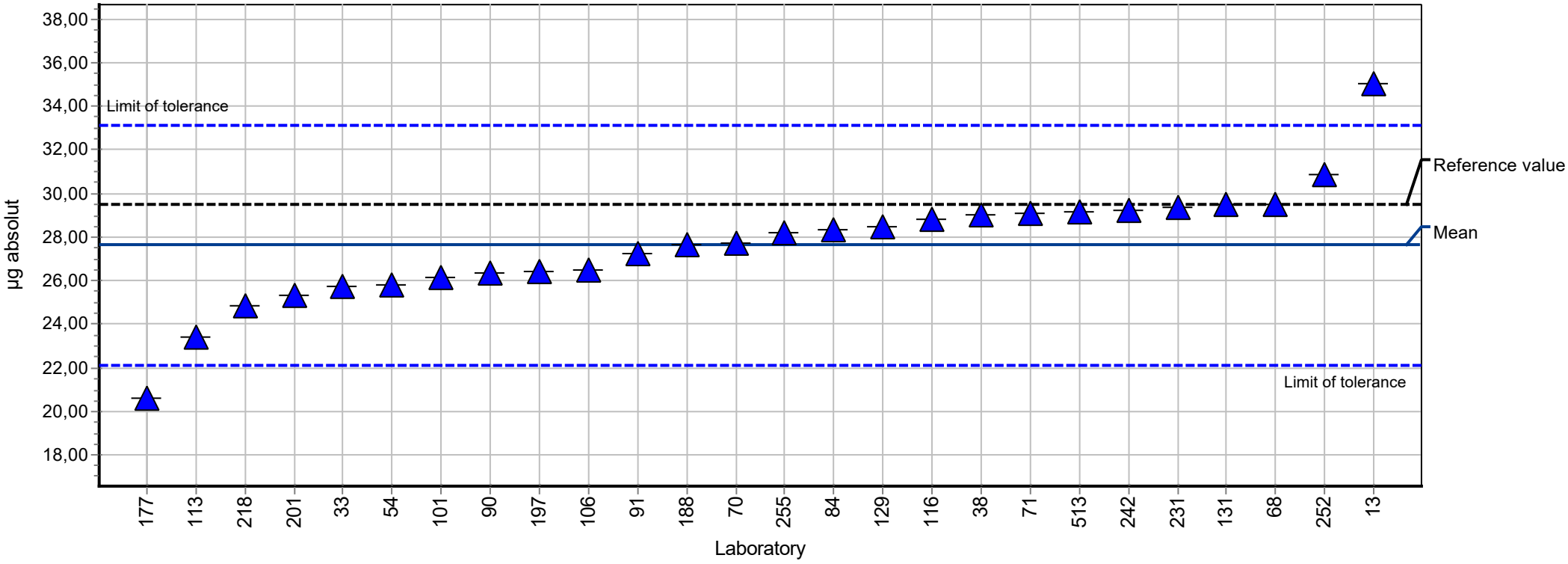
Summary results

Measurand:	**Nickel**	**Mean:**	**4,439 µg absolut**
Sample:	**2**	**Reprod. s.d.:**	**0,167 µg absolut**
Method:	**ISO 5725-2**	**Rel.reprod. s.d.:**	**3,77%**
Rel.target s.d.:	**10,00% (Limited)**	**Reference value:**	**4,050 µg absolut**
Number of laboratories in calculation + outliers:	**27**	**Range of tolerance:**	**3,551 - 5,327 µg absolut (|Z-Score| <= 2,00)**



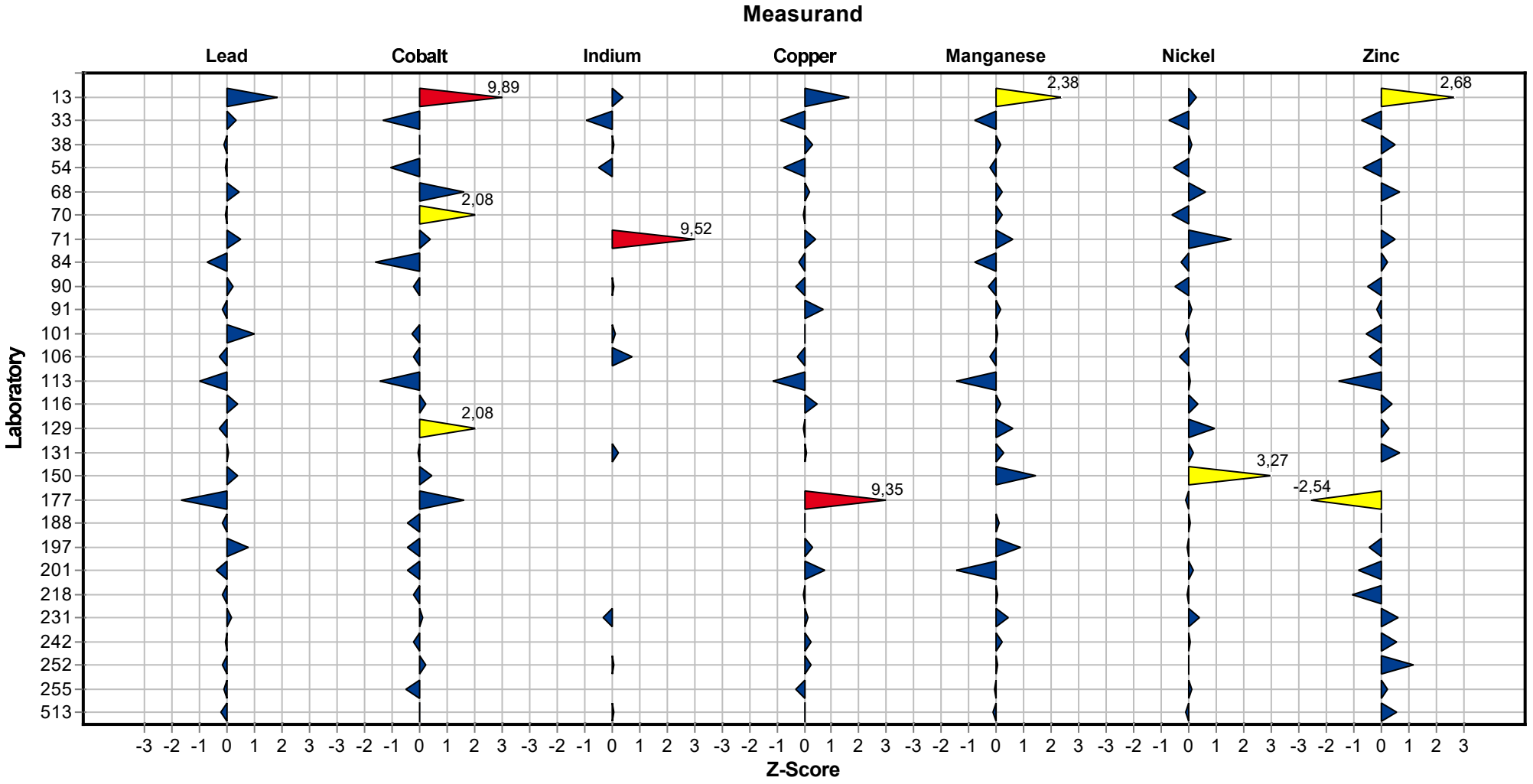
Summary results

Measurand:	**Zinc**	**Mean:**	**27,613 µg absolut**
Sample:	**2**	**Reprod. s.d.:**	**2,688 µg absolut**
Method:	**ISO 5725-2**	**Rel.reprod. s.d.:**	**9,73%**
Rel.target s.d.:	**10,00% (Limited)**	**Reference value:**	**29,460 µg absolut**
Number of laboratories in calculation:	**26**	**Range of tolerance:**	**22,091 - 33,136 µg absolut (|Z-Score| <= 2,00)**



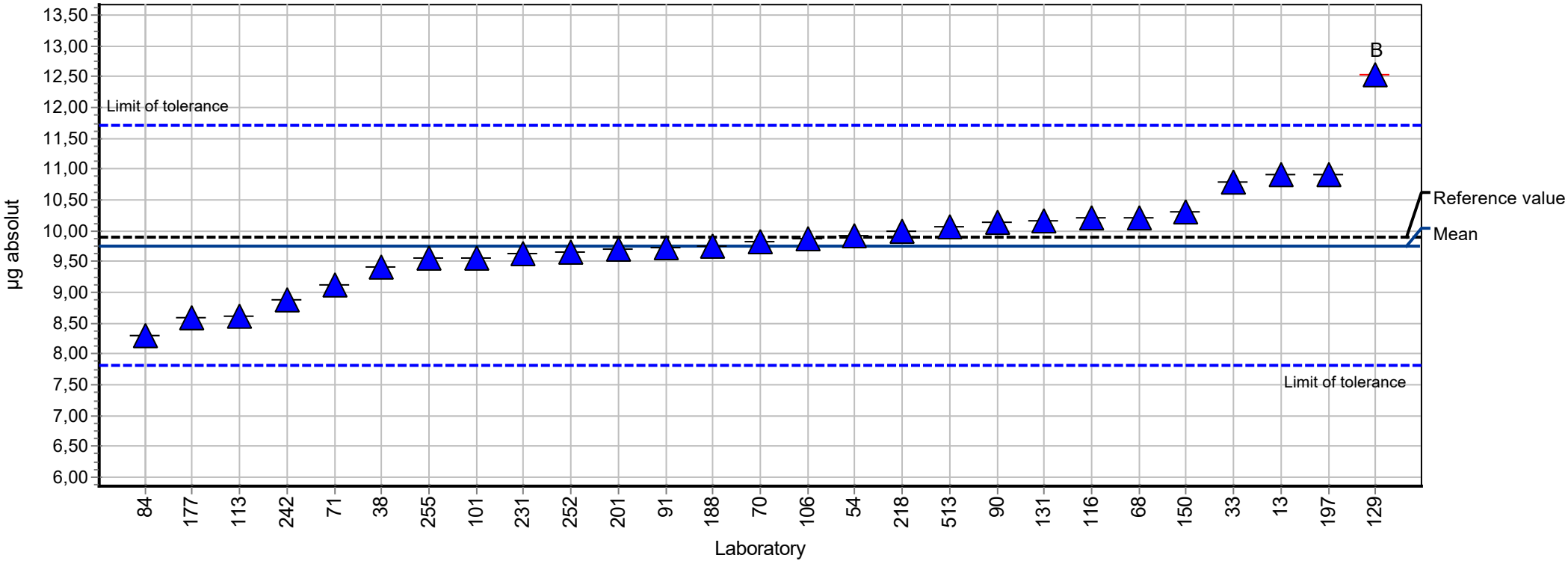
Sample chart of Z-scores

Sample 2



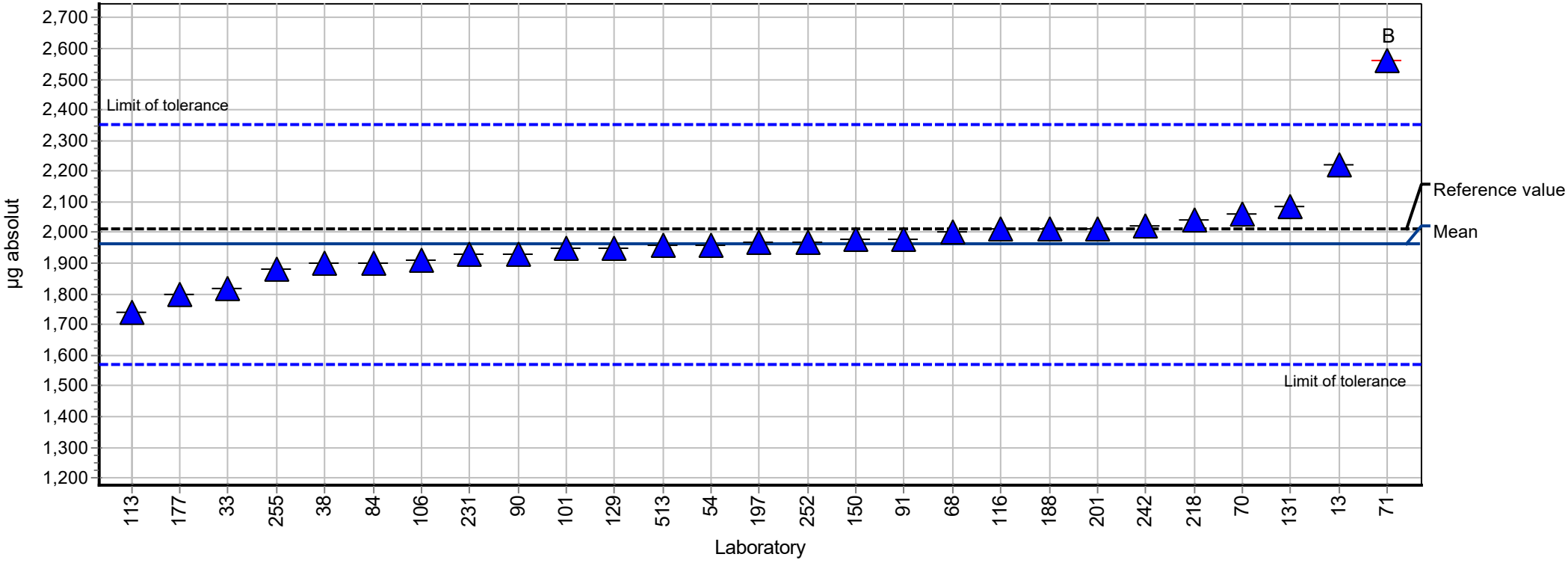
Summary results

Measurand:	**Lead**	**Mean:**	**9,761 µg absolut**
Sample:	**3**	**Reprod. s.d.:**	**0,665 µg absolut**
Method:	**ISO 5725-2**	**Rel.reprod. s.d.:**	**6,81%**
Rel.target s.d.:	**10,00% (Limited)**	**Reference value:**	**9,890 µg absolut**
Number of laboratories in calculation + outliers:	**27**	**Range of tolerance:**	**7,809 - 11,713 µg absolut (|Z-Score| <= 2,00)**



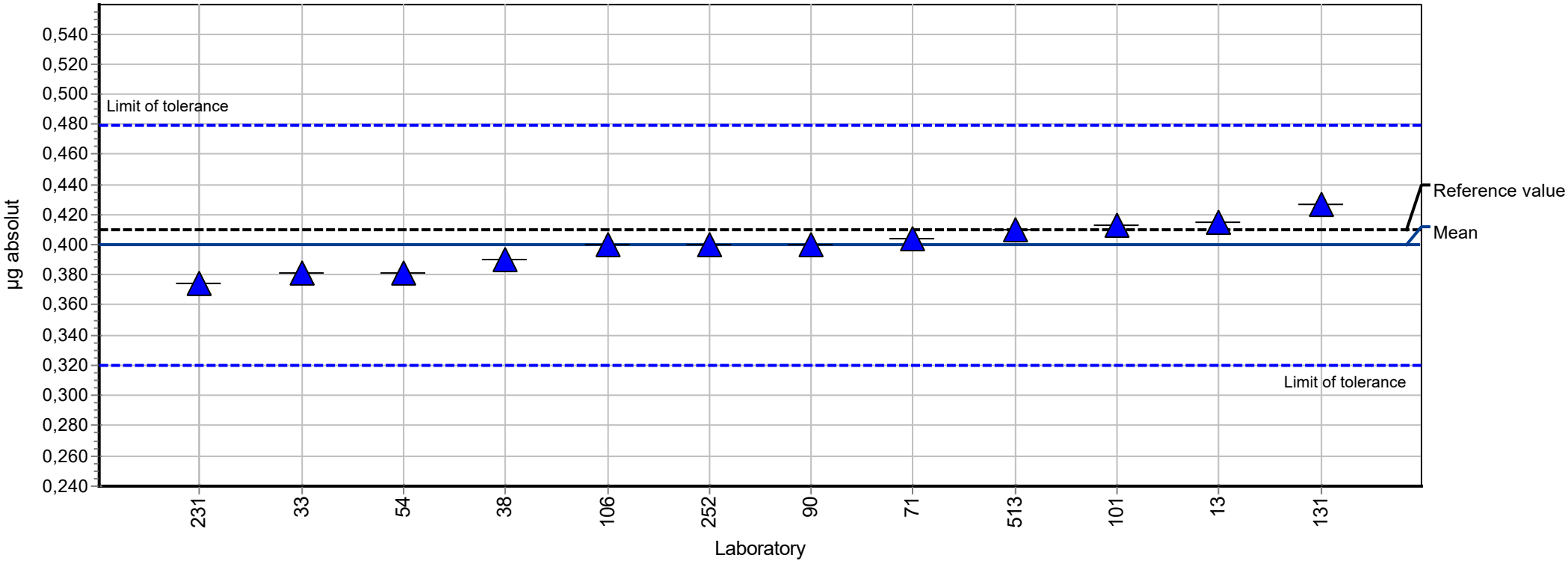
Summary results

Measurand:	**Cobalt**	**Mean:**	**1,961 µg absolut**
Sample:	**3**	**Reprod. s.d.:**	**0,095 µg absolut**
Method:	**ISO 5725-2**	**Rel.reprod. s.d.:**	**4,82%**
Rel.target s.d.:	**10,00% (Limited)**	**Reference value:**	**2,010 µg absolut**
Number of laboratories in calculation + outliers:	**27**	**Range of tolerance:**	**1,569 - 2,353 µg absolut (|Z-Score| <= 2,00)**



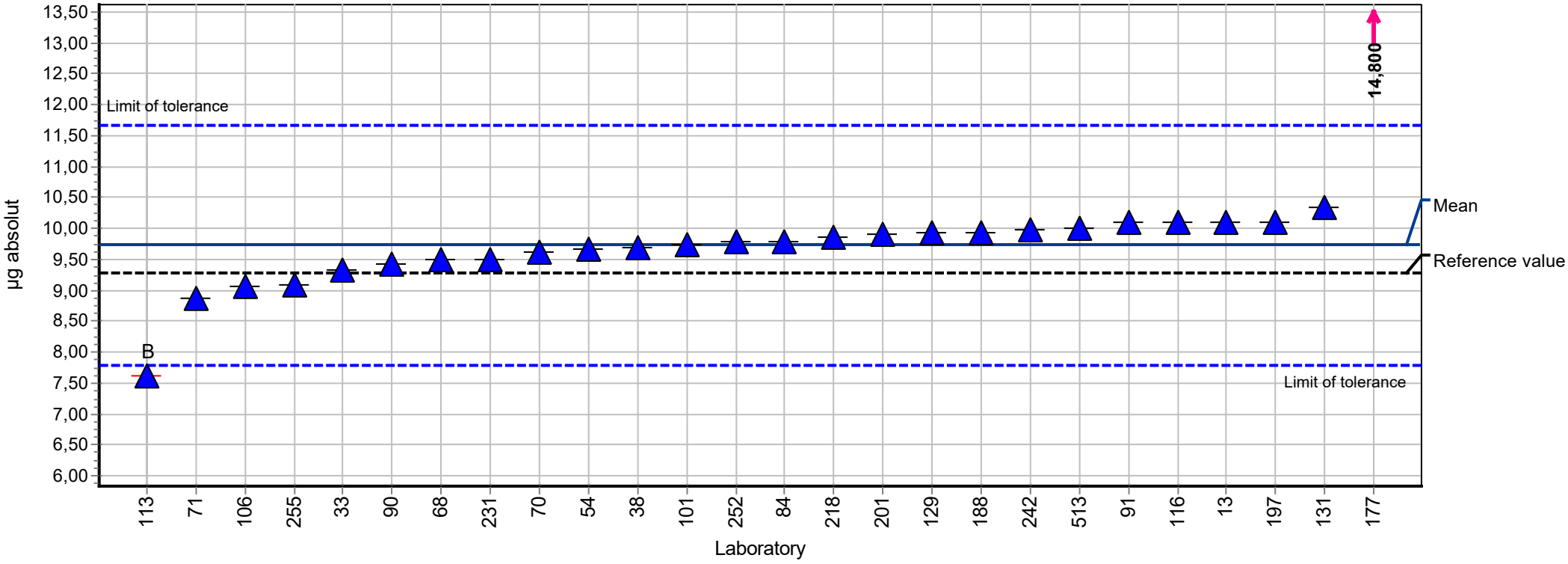
Summary results

Measurand:	**Indium**	**Mean:**	**0,400 µg absolut**
Sample:	**3**	**Reprod. s.d.:**	**0,016 µg absolut**
Method:	**ISO 5725-2**	**Rel.reprod. s.d.:**	**3,95%**
Rel.target s.d.:	**10,00% (Limited)**	**Reference value:**	**0,410 µg absolut**
Number of laboratories in calculation:	**12**	**Range of tolerance:**	**0,320 - 0,480 µg absolut (|Z-Score| <= 2,00)**



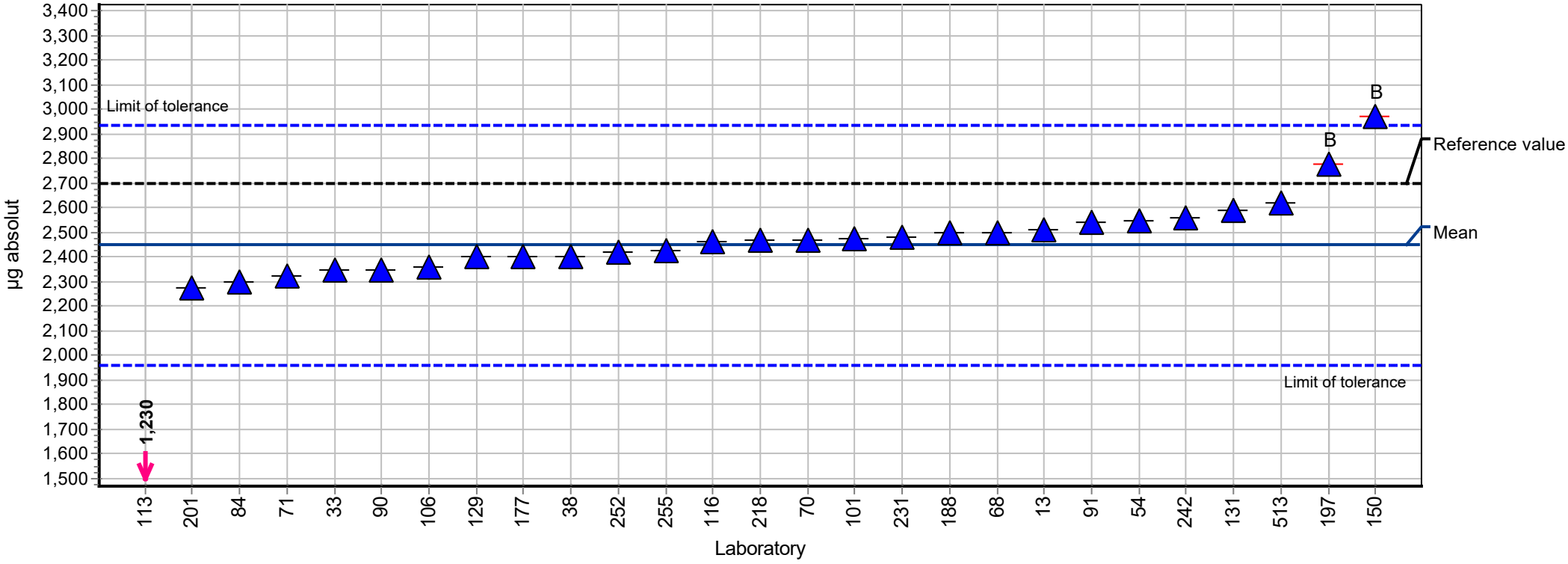
Summary results

Measurand:	**Copper**	**Mean:**	**9,728 µg absolut**
Sample:	**3**	**Reprod. s.d.:**	**0,367 µg absolut**
Method:	**ISO 5725-2**	**Rel.reprod. s.d.:**	**3,77%**
Rel.target s.d.:	**10,00% (Limited)**	**Reference value:**	**9,290 µg absolut**
Number of laboratories in calculation + outliers:	**26**	**Range of tolerance:**	**7,782 - 11,673 µg absolut (|Z-Score| <= 2,00)**



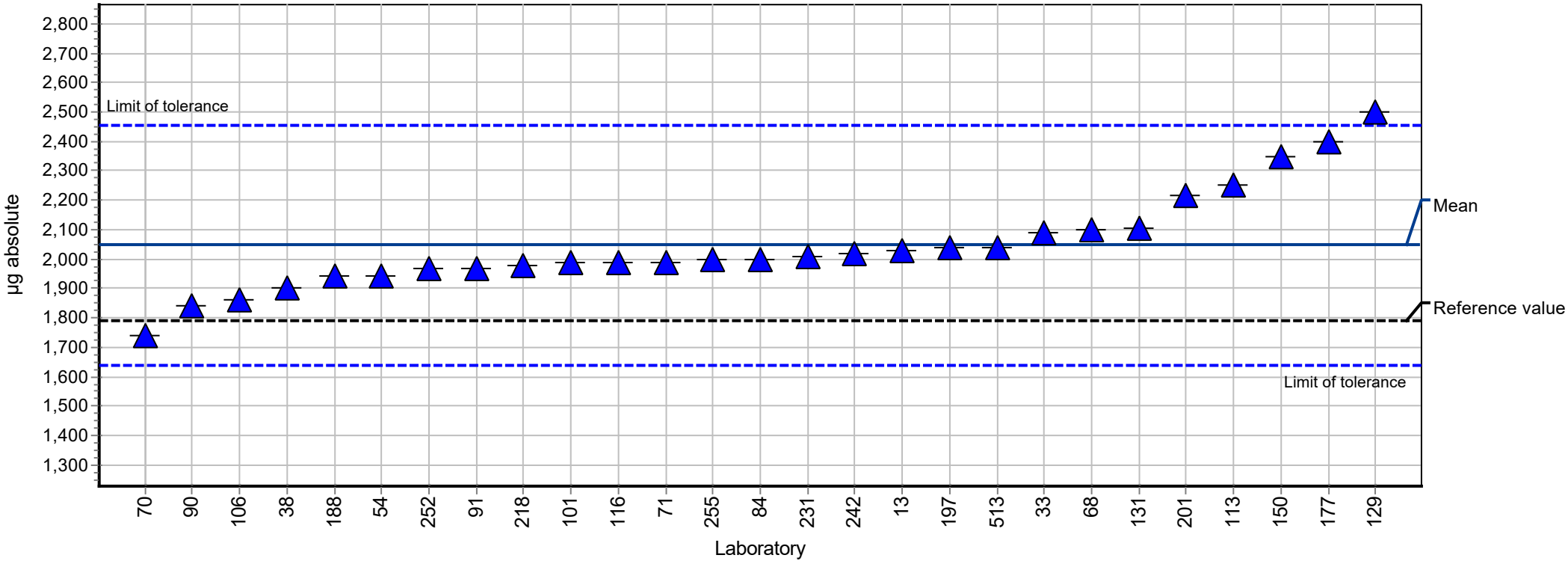
Summary results

Measurand:	**Manganese**	**Mean:**	**2,447 µg absolut**
Sample:	**3**	**Reprod. s.d.:**	**0,092 µg absolut**
Method:	**ISO 5725-2**	**Rel.reprod. s.d.:**	**3,78%**
Rel.target s.d.:	**10,00% (Limited)**	**Reference value:**	**2,700 µg absolut**
Number of laboratories in calculation + outliers:	**27**	**Range of tolerance:**	**1,958 - 2,937 µg absolut (|Z-Score| <= 2,00)**



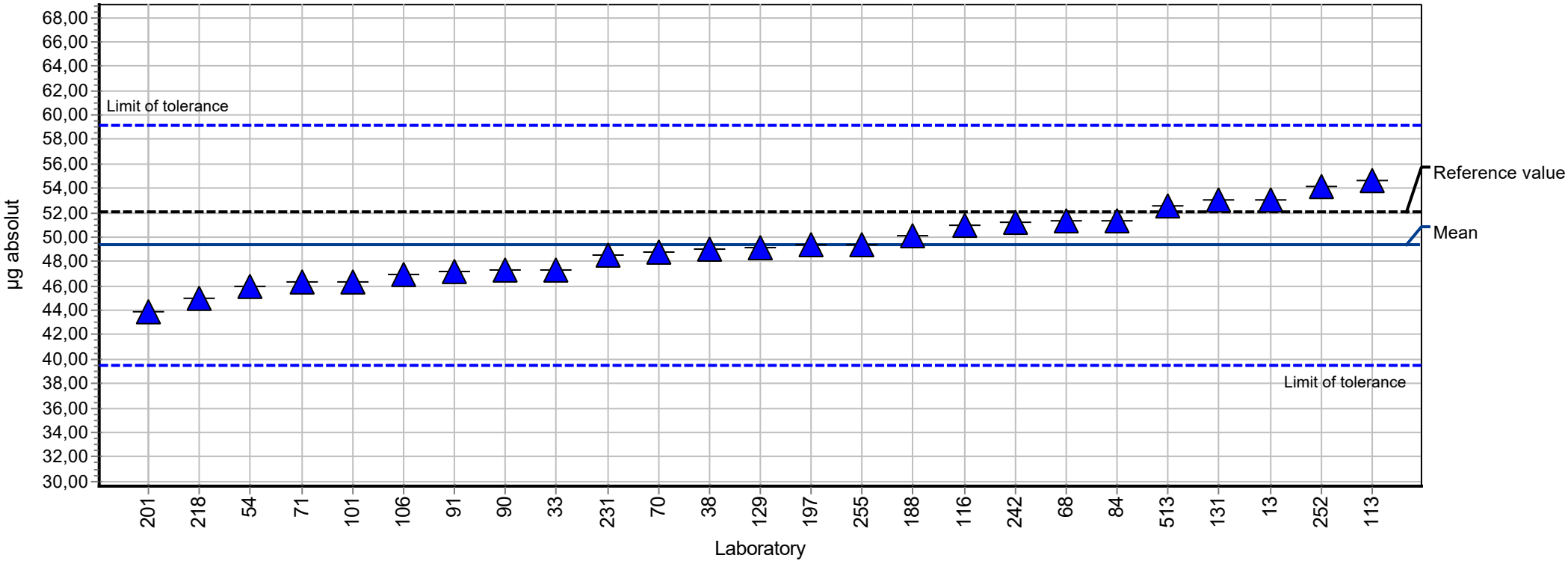
Summary results

Measurand:	**Nickel**	**Mean:**	**2,046 µg absolute**
Sample:	**3**	**Reprod. s.d.:**	**0,170 µg absolute**
Method:	**ISO 5725-2**	**Rel.reprod. s.d.:**	**8,30%**
Rel.target s.d.:	**10,00% (Limited)**	**Reference value:**	**1,790 µg absolute**
Number of laboratories in calculation:	**27**	**Range of tolerance:**	**1,637 - 2,456 µg absolute (|Z-Score| <= 2,00)**



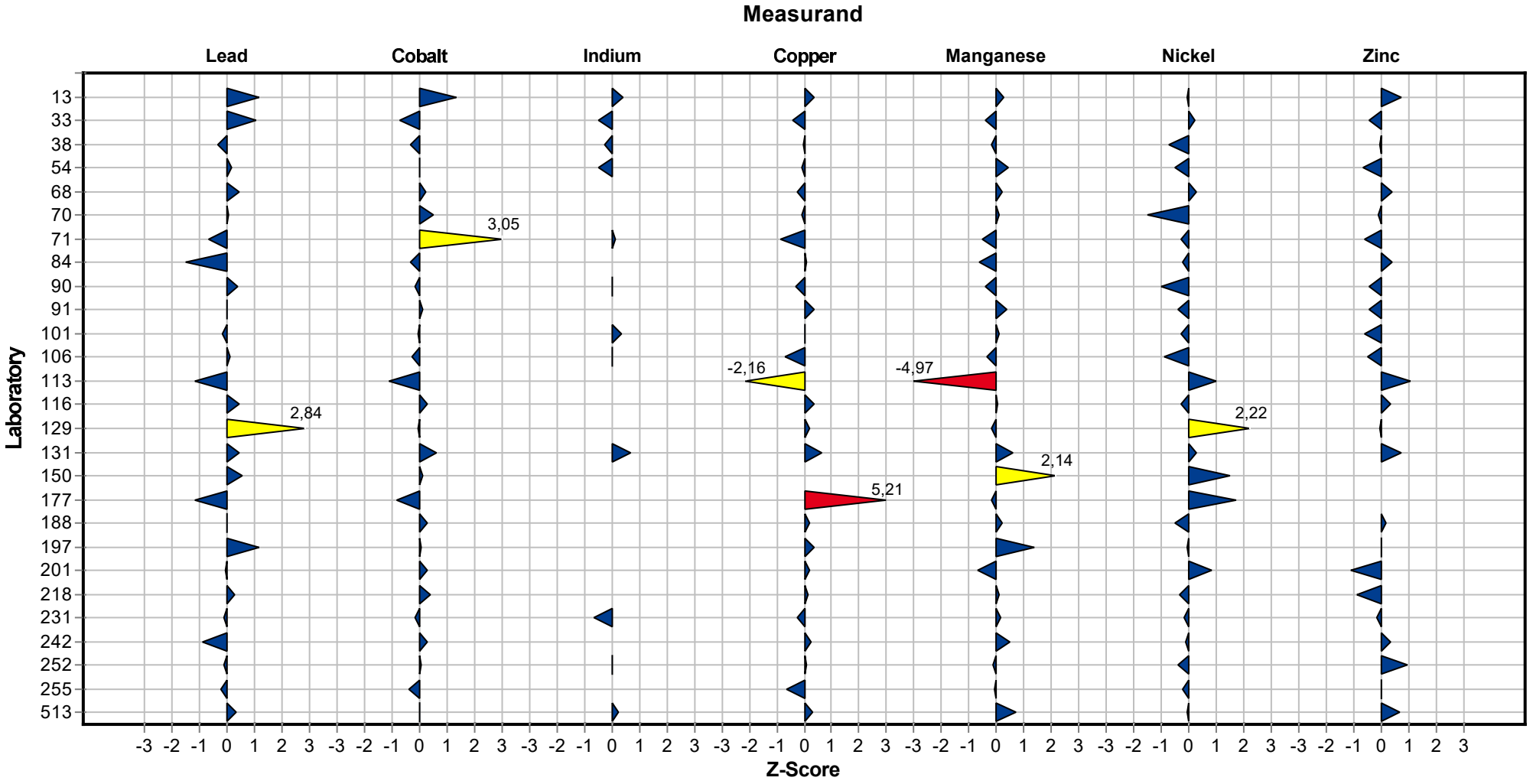
Summary results

Measurand:	**Zinc**	**Mean:**	**49,325 µg absolut**
Sample:	**3**	**Reprod. s.d.:**	**2,900 µg absolut**
Method:	**ISO 5725-2**	**Rel.reprod. s.d.:**	**5,88%**
Rel.target s.d.:	**10,00% (Limited)**	**Reference value:**	**52,030 µg absolut**
Number of laboratories in calculation:	**25**	**Range of tolerance:**	**39,460 - 59,190 µg absolut (|Z-Score| <= 2,00)**



Sample chart of Z-scores

Sample 3



Questions and Answers

Participant	pulping method	acid concentration
13	ASTM D8344	10% 1% Ammoniumbifluoride and 20 % concentrated HNO3
33	ISO 15202-2	
38	Standard-Mikrow ellenaufschluss IFA-Arbeitsmappe (Blatt 6015)	Salpetersäure Suprapur 69%
54	nach IFA Arbeitsmappe Blatt 6015, Mikrow ellenaufschluss	65 % Salpetersäure
68	Heizblock digiPrep	37% HCl / 65% HNO3
70	Mikrow ellenaufschluss	10ml 65% Salpetersäure
71	nach BIA	HNO3 65%ig , HCL 30%ig
84	IFA 6015 offener Standardaufschluss	65% HNO3, 25%HCl
90	Microw ave digestion method	HNO3 65%
91	Mikrow ellendruckaufschluss	HNO3 65%
101	IFA-Arbeitsmappe (Blatt 6015)	Salpetersäure 69%
106	Lösung in 65 % Salpetersäure bei 80 °C	65 % Salpetersäure
113	IFA Blatt 6015	32% HCL und 65% HNO3
116	IFA-Arbeitsmappe, Blatt 6015	HCl:30% HNO3:65%
129	IFA Arbeitsmappe (Blatt 6015)	
131	IFA 6015	65% p.a.
150	Mikrow ellendruckaufschluss nach IFA 6015	65%
177	IFA-Arbeitsmappe 6015	Salpetersäure 65% / Salzsäure 37%
188	offener Standardaufschluss nach IFA-Arbeitsmappe (Blatt 6015)	HNO3 >65 %, HCl 25 %
197	offener Aufschluß - IFA 6015:2018-02	65% HNO3/25%HCL
201	IFA 6015, offener Aufschluss	Salpetersäure 69%, Salsäure 35 %
218	Mikrow ellendruckaufschluss	HNO3 (65 %), H2O2 (30 %)
231	IFA 6015	Salpetersäure Supra 69 %
242	Geschlossenen MW (Turbow ave)	HNO3 65 %ig
252	Angeleht an IFA-Arbeitsmappe (Blatt 6015) - Standard-Mikrow ellendruckaufschluss	entsprechend IFA-Arbeitsmappe
255	Mikrow ellenaufschluss IFA 6015	67-69 % HNO3 / 30 % HCl
513	Angelehnt an IFA-Arbeitsmappe Blatt 6015_offener Aufschluss	Entsprechend IFA-Arbeitsmappe Blatt 6015

Participant	mixing ratio	time of pulping

Participant	mixing ratio	time of pulping
13	5ml Ammoniumbifluoride and 10ml HNO3	1 hour (2 x 30 minutes)
33	1:1	2 Stunden
38	pur	60 min
54	65 % Salpetersäure	Rampe 15 min, Haltezeit 45 min
68	1:2	120 Minuten bis 115°C
70	10ml Salpetersäure	in 15min auf 220°C, in 5min auf 240°, das 45min gehalten -> 65min
71	6,6ml :3,3mL	2h
84	2:1	2h
90		0 à 1100 W en 15 min avec palier de 45 min et refroidissement de 30 min
91		0,5h
101	reine Salpetersäure (69%) eingesetzt	1 Stunde
106	nur Salpetersäure	2 h
113	1:2	2h
116	2:1	2
129	2:1	2h
131		90 min
150	100% Salpetersäure	1h
177	2:1	2
188	2:1	2 h unter Rückfluss bei Siedetemperatur
197	2:1 (10 ml gesamt)	2h
201	Salpetersäure/Salzsäure 2:1	3 h
218	5 : 1	2 Stunden
242	-	50 min
252	10 ml HNO3	1 h
255	10 ml HNO3 + 0,5 ml HCl	1 h 20 min
513	Entsprechend IFA-Arbeitsmappe Blatt 6015	0,5 h

Participant	reagent volume	equipment
13	50ml	Thermo Scientific iCAP Q ICP-MS
33	5 ml Salpetersäure, 5 ml Salzsäure	offener Aufschluss
38	10 ml	Turbow ave
54	10 ml	Mikrow elle

Participant	reagent volume	equipment
68	50 ml (Endvolumen)	ICP-OES
70	auf 25ml aufgefüllt	mikrowellenassistierter Druckaufschluss
71	25 mL	offen
84	10ml Säure auf gefüllt auf 20ml	unter Rückfluss
90	10 ml	ICPMS AGILENT 7700X
91	5mL	Mikrowelle
101	25mL und anschließend 1:100 verdünnt	geschlossen
106	16,25 ml	geschlossen
113	20ml	Rückfluss
116	20	Digi-Prep
129	20	offen unter Rückfluss
131	10 ml	MARS 6 (Mikrowelle)
150	10 ml	MarsXpress
177	25	unter Rückfluss
188	10ml	100 ml Bechergläser, 25ml Meßkolben, Rückflussapparatur, ICP-OES Vista Pro - Varian
197	Aufschluß in 10 ml, dann auffüllen auf 20 ml	digi-prep
201	12 ml	Behr Aufschlussblock
218	12 mL	MLS START 1500
231	10 ml	Mikrowelle CEM Mars 6
242	5 ml	Quarzglas
252	50 ml	Mikrowellendruckaufschluss
255		ICP-MS
513	50 ml	offener Aufschluss

Participant	method for cobalt	Methode für Blei	method for zinc	method for copper	method for nickel	method for indium
13	SOP-LCA-31	SOP-LCA-31	SOP-LCA-31	SOP-LCA-31	SOP-LCA-31	SOP-LCA-31
33	ISO 30011 mit ICP-MS	ISO 30011 mit ICP-MS	ISO 30011 mit ICP-MS	ISO 30011 mit ICP-MS	ISO 30011 mit ICP-MS	ISO 30011 mit ICP-MS
38	IFA (Blatt 6015)	IFA (Blatt 6015)	IFA (Blatt 6015)	IFA (Blatt 6015)	IFA (Blatt 6015)	IFA (Blatt 6015)
54	DIN EN 16171:2017-01	DIN EN 16171:2017-01	DIN EN 16171:2017-01	DIN EN 16171:2017-01	DIN EN 16171:2017-01	DIN EN 16171:2017-01
68	2.009	2.009		2.009	2.009	
70	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	w urde nicht bestimmt
71	ICP-OES	ICP-OES	ICP-OES	ICP-OES	ICP-OES	ICP-OES

Participant	method for cobalt	Methode für Blei	method for zinc	method for copper	method for nickel	method for indium
84	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS
90	mode collision sous He	mode sans collision	mode collision sous He	mode collision sous He	mode collision sous He	mode sans collision
91	ICP-OES	ICP-OES	ICP-OES	ICP-OES	ICP-OES	
101	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS
106	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS
113	ICP-OES	ICP-OES	ICP-OES	ICP-OES	ICP-OES	
116	ICP-OES	ICP-OES	ICP-OES	ICP-OES	ICP-OES	
129	AAS/Flamme	AAS/Flamme	AAS/Flamme		AAS/Flamme	
131	NIOSH 7301	NIOSH 7301	NIOSH 7301	NIOSH 7301	NIOSH 7301	NIOSH 7301
150	DGUV-I 213-515 Nr. 4	DGUV-I 213-573			DGUV-I 213-510 Nr. 2	
177	ICP/OES	ICP/OES	ICP/OES	ICP/OES	ICP/OES	
188	ICP-OES	ICP-OES	ICP-OES	ICP-OES	ICP-OES	
197	IFA 7808:2013-12	IFA 7808:2013-12	IFA 7808:2013-12	IFA 7808:2013-12	IFA 7808:2013-12	
201	IFA 7808, ET-AAS	IFA 6310, ET-AAS	IFA 8985, F-AAS	IFA 7755, ET-AAS	IFA 8095, ET-AAS	
218	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	nicht bestimmt
252	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS
255	IFA 7808	IFA 7808	IFA 7808	IFA 7808	IFA 7808	Keine Analyse durchgeführt
513	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS

Participant	method for manganese
13	SOP-LCA-31
33	ISO 30011 mit ICP-MS
38	IFA (Blatt 6015)
54	DIN EN 16171:2017-01
68	2.009
70	ICP-MS
71	ICP-OES
84	ICP-MS
90	mode collision sous He
91	ICP-OES
101	ICP-MS
106	ICP-MS

Participant	method for manganese
113	ICP-OES
116	ICP-OES
129	AAS/Flamme
131	NIOSH 7301
150	DFG 2021, Vol6, Issue 1 Mangan und seine anorg. Verbindungen
177	ICP/OES
188	ICP-OES
197	IFA 7808:2013-12
201	ET-AAS
218	ICP-MS
252	ICP-MS
255	IFA 7808
513	ICP-MS